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CIVIL ENGINEERING.

On Sub-Marine Foundations; particularly the Screw-pile and Moorings. *By* MR. A. MITCHELL, of Belfast, Assoc. Inst. C. E.

Considering that the entire subject of the various sorts of piling, of solid stone foundations, of coffer-dams, of masses of concrete, and the numerous modes adopted by ingenious men for overcoming local difficulties, would occupy too much time, and scarcely possess novelty, the author restricted himself almost entirely to the description of the works executed by him with the screw-pile, as that had been chiefly employed for supporting structures on loose sand or mud banks, wholly or partially covered by the sea, where it had been previously considered very hazardous, if not impracticable, to erect any permanent edifice; and in his narrative, he scrupulously avoided all comparison with other modes of proceeding, even when they had the same object. The origin of the screw-pile was the screw-mooring, which was designed for the purpose of obtaining, for an especial purpose, a greater holding power than was possessed by either the ordinary pile or any of the usual mooring-anchors, or blocks, of however large dimensions. It was proved by experiment, that if a screw, with a broad spiral flanch, were fixed upon a spindle, and forcibly propelled by rotary motion to a certain depth into the ground, an enormous force would be required to extract it by direct tension; and that the power employed must be sufficient to drag up a mass of earth of the form of the frustrum of a cone reversed—the base being at the sur-

face of the ground, and the section of the apex being equal to the diameter of the screw. The extent of the resisting mass must, of course, depend upon the natural tenacity of the soil. Even in this reasoning, it must be evident that a vertical force was calculated upon; but as, practically, that seldom if ever occurred, the angle of tension and the curve of the buoy-cable again gave the moorings greater power. This was found to be correct in practice, and the application of the moorings became very extensive. An arrangement was made with the port of Newcastle-on-Tyne, by which, for the sum of 2500*l*, the right of fixing these moorings in the Tyne was given; and Mr. Brookes, the engineer, showed that last year, whilst in the neighboring port, damage was done to the shipping to the extent of nearly 30,000*l*., no injury was sustained in the Tyne, entirely owing to the sound holding of Mitchell's screw-pile moorings It naturally occurred to Mr. Mitchell, that the same means of resistance to downward pressure might be used; and he proposed to apply it for the foundations of lighthouses, beacons, and other structures, which, for maritime purposes, it might be desirable to place upon sand and mud banks, where hitherto it had been considered impracticable to place any permanent edifice. In the year 1838, a plan for a structure of this nature for a lighthouse, on the Maplin Sand, at the mouth of the Thames, was laid before the corporation of the Trinity House, supported by the opinion of James Walker, Esq., their engineer. The nine iron piles, 5 inches diameter, with screws 4 feet diameter, were accordingly driven 22 feet deep into the mud, and, with proper precaution, they were allowed to stand for two years before any edifice was placed upon them. The lighthouse was subsequently constructed, and, as was testified by Mr. Walker, had stood perfectly until the present time. Pending this probation, it was determined to erect a lighthouse to point out the entrance to the harbor of Fleetwood-on-Wyre, and under the advice of Captain Denham, R. N., the screw-piles were adopted. The spot fixed on was the point of a bank of loose sand, about two miles from the shore; seven iron piles, with screws of 3 ft. diameter, were forced about 16 feet into the bank, and upon them timber supports 48 feet in vertical height were fixed to carry the house and lanthorn. This structure was completed in six months, and was perfectly successful, never having required any repairs to the present time. A similar lighthouse was erected near Belfast; and since then several others, with a great number of beacons, have been fixed in situations heretofore deemed impracticable.

A project was started by the Earl of Courtown, in the year 1847, for adding to the length of the pier at the Harbor of Courtown, on the coast of Wexford, which had proved an entire failure, from the channel between the solid pier being continually choked up with sand. Iron piles, with screws of 2 feet diameter, to be driven from 11 feet to 15 feet into the sand, and blue clay, were decided to be used in order to form an open jetty through which the sand could be washed by the current, and the platform would be used for loading and discharging the shipping. The surf was so heavy on the coast that the usual barges or floating rafts could not be used for putting the piles

down—so an ingenious plan was designed by Mr. Mitchell, for projecting a stage forward from the solid part, rigging a large grooved wheel upon the top of the pile, passing an endless rope-band around it, and round a pulley fixed 150 feet back, and then, by a number of men hauling upon the band, a rotary motion was communicated to the pile, which screwed it down very fast. By these means one bay of the pier, 17 feet long, was finished daily, even in very rough weather. The entire length of the jetty was 260 feet, its breadth 18 feet, with a cross-head 54 feet long, with landing stages at each end, and two lines of railway throughout. The entire cost of this extension was 4150*l.*, or about 47*l.* 10s. per lineal yard—an extremely small sum compared with the cost of stone piers; but even that was more than the expense would be now, as the system of work is better understood, and materials are now cheaper. The account of the difficulties incurred in the execution of these works was most interesting, and ample testimony was borne by engineers of eminence, and men whose maritime experience gave weight to their opinion, of the superiority of Mr. Mitchell's screw-piles and moorings over every other system for holding buoys or for supporting beacons and light-houses, and their use was suggested for the foundation of bridges, viaducts, and numerous railway and other works, as well as a multiplicity of applications which had not hitherto been thought of.

Mr. W. A. Brookes gave an account of the method of laying down the moorings at Newcastle-on-Tyne, under his directions. A heavy chain, formed of 3¼ inch round iron, in links of 3 feet long each, was stretched along the bed of the river, in the direction of the current. To this chain beneath each tier, was attached a 2½ inch mooring-chain, fixed to the head of a screw mooring; another screw being also placed beneath each tier, and driven down between 10 and 20 feet into the clay, and sometimes full a foot into the shale rock. The screws were 4 feet in diameter, and were placed in depths varying from 15 feet to 24 feet at low-water spring tides. They were screwed down to the depth of 15 feet in an hour and a half, and sometimes 21 feet in two hours. Each mooring-screw was intended to have borne the strain of four heavy ships; but, during the last winter, the port was so crowded, that more than double the proper number of vessels were moored upon each: and yet there were no signs of weakness; and whilst nearly 30,000*l.* of damage was done at Sunderland, during a heavy storm, no casualties occurred at Newcastle, which Mr. Brooks stated was entirely owing to the sound holding of the screw moorings. He argued, therefore, that the small sum of 2500*l.*, paid by the harbor commission of Newcastle for the right to put down these moorings, was a very wise expenditure.

Mr. T. Smith, Pilot Master of the Port of Shields, corroborated Mr. Brooks's statement.

Captain Washington, R. N., had, in the course of his surveying duties, seen the screw moorings in almost every position, and had heard them universally eulogized, as being the best and safest moorings hitherto known. He strongly recommended their employment. He had also examined carefully the screw-pile lighthouses, and had

every reason to be satisfied with them, as affording a means of placing lighthouses and beacons where they were before impracticable, and enabling floating lights to be generally superseded by fixed lights, which latter he proved, from documentary evidence, to be one-third less annual cost than the former, and certainly more useful to sailors; for, in spite of all the care, attention, and even lavish expenditure of the Trinity Board to moor the lightships securely, they did go adrift just at the time when they were most required. He, therefore, advocated fixed lights in every situation where a foundation could be obtained; and he believed that, with the screw-pile, there were scarcely any situations where this could not be accomplished.

Messrs. Walker, Cubitt, Rennie, Murray, Moorson, Mitchell, Scott, Russell, and others, took part in the discussion, adducing instances of the efficacy of the moorings and the piles, and of their applicability to numerous engineering works, for which they expressed their intention of employing them. The high price hitherto charged for the right of using them had somewhat retarded their general introduction; but it was explained, that Mr. Mitchell had feared to entrust to others the fixing of them, lest a failure might ensue before his system was perfected, which, however, he now thought it was. Now, however, as the right of granting licenses for their use was transferred to men of business who had purchased it, there was no doubt of their being brought within the reach of every application.—*Proceed. Inst. of Civ. Eng.*

Civ. Eng. & Arch. Journ.

Remarks on the Formation of the Entrances to Docks, situated upon a Tideway. By Mr. J. B. Redman, M. Inst. C. E.

After illustrating the subject by the example of the position and direction of all the principal dock entrances on the borders of the Thames in the port of London—showing that the variation in the opinions and practice of engineers had been very great—the paper detailed the ordinary methods of docking and undocking ships, and the precautions to be taken in constructing entrances, which should be best adapted for facilitating these operations; and, although it was difficult to lay down any positive rules upon the subject, as the engineer must, in almost every case, be guided by local circumstances, yet in ordinary cases the following general rules were recommended:—For graving docks, an angle of about 45°, pointing up the stream; for wet docks, an angle of about 60°, in the same direction; and a right angle, with the stream, for building ships. These, it was believed, would be generally found the most available.

In the discussion upon Mr. Redman's paper, the merits and defects of the several dock entrances in the Thames and in other situations were examined, and the general result appeared to be, that although the engineer must be guided by local circumstances, yet, that in situations where the river was sufficiently wide, and the position of the land permitted, an acute angle pointing up the stream, was the best for docking vessels with the flood—that the reverse would be best for

undocking ships. In ordinary widths of rivers, therefore, the end would be attained by forming a bay sufficiently deep to render the water still in front of the dock, the wing walls being so much splayed as virtually to give the directions up and down the stream as circumstances required. The peculiar positions of the docks at Ipswich, by Mr. Palmer, the alterations of the Duke's Dock at Liverpool, by Mr. Cubitt, and other cases, were sustained in support of the arguments of the speakers, who all united in praising the industry and talent of Mr. Redman, in bringing forward the subject in the complete manner he had done.—*Ibid.* Ibid.

An Account of the Effect of the Storm of the 6th of December, 1847, on the Coast near Edinburgh, as illustrating the Principles of the Construction of Sea Defences. By W. J. M. Rankine.

The principle example given was the sea wall of the Leith branch of the Edinburgh and Dalkeith Railway, built by the author in the year 1837, from Mr. Walker's designs. Just after it was completed, a violent storm occurred, which injured almost every similar work within its range, but produced no ill effect upon that structure. On the 6th of December 1847, a still more violent storm occurred, which did great damage all around, but the railway wall still escaped without injury. The total length of the wall was about 750 yards; its height was 13½ feet above the beach at the highest point, diminishing to about 6 feet at the ends. The height of the top was 4 feet above equinoctial spring tide level. Its least thickness was 5 feet and its greatest 10 ft.; the back was vertical, but the face had an inclination at the lower part of 5 inches in the foot, gradually becoming curved as it rose upwards, until at the top it overhung slightly. The foundation course was composed of large flat stones, laid horizontally 4 feet below the surface of the beach, upon a stratum of fine sand and gravel, firm when dry, but movable when wet. The face was of hammer-dressed ashlar, about 2 feet thick; the back of rubble, 18 inches thick. The interior was filled with concrete. The coping was composed of stones each weighing about half a ton, connected by means of cast-iron dowels. The stone used was Craiglieth sandstone. The face-joints were laid in cement for a depth of 4 inches. The foundation was protected by a pitching of trap boulders, laid on the natural level of the beach. They were partially disturbed by the storm referred to, and the author ascribed this to their weight being insufficient to resist the vertical oscillation of the waves.

The second example was a vertical sea wall near Trinity, the foundation of which was protected by a dry stone bulwark sloping at angles of from 30° to 40°. The wall was injured by the storm, but the pitching was breached at several points.

The third example was another wall near Trinity, of a hyperbolic section. The lower part had a slope built dry up to a little below high-water mark. At this point there was a sharp curve, and the upper part was nearly vertical, and laid in mortar. The waves ex-

tracted the stones of the curved portion, and the upper part, being undermined, was destroyed to a great extent.

The last example was the bulwark of the Granton line, the lower part of which sloped at about 20°; the upper portion was curved, and was covered by a heavy projecting string-course and parapet. It was built dry, and the stones of the lower part weighed not less than half a ton each. This bulwark suffered damage to a slight extent on its upper portion.

These examples were stated to confirm the following principles:—That the principal action of the waves in front of a sea wall was a vertical oscillation, produced by the combination of the direct and the reflected waves; that a sloping bulwark gave rise to a sloping oscillation, tending to overturn any portion which projected above the line of slope; that where the strength of a sea wall depended on the pressure of the superincumbent masonry, and the adhesion of mortar and cement, the position of greatest stability was vertical; and that when the strength depended on the weight of the individual stones, the position of greatest stability was a very flat slope.

In the discussion which ensued, instances were adduced of the duration of vertical walls under the attacks of heavy seas, and, on the other hand, of their destruction when flat slopes had effectually resisted the waves; and it was agreed that in this, as in all other cases of engineering, no empirical rules should be laid down, but that the skill of the engineer should be exerted to adopt such forms of construction as were best adapted to the locality and the circumstances.—*Ibid.*

Ibid.

Description of the Tubular Bridge to convey the Chester and Holyhead line of Railway over the river Conway.

As this bridge which is constructed to carry the Chester and Holyhead line of Railway over the River Conway, is a unique example of engineering skill, we purpose giving a brief description of its nature, and of the effort made to raise it to its ultimate destination.

The idea furnished by the word "tube," gives no idea of its form, inasmuch as that is suggestive of a circularly-formed tunnel, whereas in fact, the bridge rather resembles a huge chest, such an one as the genii of the Eastern romances might be supposed to fabricate.

The TUBE is made of wrought-iron plates, varying in thickness from ¾ inch to 1 inch, rivetted together, strengthened by T irons; and, to give additional strength to the whole, a series of cells is formed at the top and at the bottom of the tube, between an inner ceiling and floor and the exterior plates. It is to be observed that T irons strengthen the top and sides, and the iron plates which form the cells are rivetted and held in their places by angle irons. The upper cells, eight in number, in the transverse section, are nearly square, being 1 foot 9 inches high, and 1 foot 8¼ wide. The lower cells, six in number, are 2 feet 3½ inches wide, by 1 foot 9 inches high. The space between wall and wall, if we may so speak, of the tube, is 14 feet, and the height of the whole, inclusive of the cells, is 22 feet 3½ inches at the

ends, and 25 feet 6 inches at the centre The total length of the tube is 412 feet. One end of the tube will be fixed to the masonry of the pier, but the other end will be so arranged as to allow for the expansion of the metal by the action of atmospheric variations, and will therefore rest upon eleven rollers of iron, running on a bed plate; and, that the whole weight of the tube may not be carried by these rollers, six girders are carried over the tube and rivetted to the upper parts of the sides of the tube, and these side portions rest upon 12 balls of gun metal running in grooves, which are fixed to iron beams let into the masonry.

The machinery for raising this stupendous piece of iron-work consists of two hydraulic rams, one at either pier. The rams are fixed on massive bearing girders, which are firmly bedded in the masonry of the piers. There is a bearing girder, and another iron girder is fixed into the piers about 18 feet above the bearing girder; and into this the guide rods from the press, to steady the cross-head when in action, are fastened. The screws of the clams or vices for clipping the chains, are turned by wheels, the upper clams being used for "clipping," or holding fast, whilst the ram is rising and lifting the chains, and the lower ones, after the ram has risen, to hold the chains in their places, and prevent them from slipping, whilst the cross-head comes down to take a fresh lift. The chains are of wrought iron, each link six feet in length from centre to centre of pin-holes; and they have shoulders at the end of the links, into which the clams fit when closed, and thus they are effectually prevented from slipping down. The sides of the clams, or vices, being moved by right and left screws, they require but *one* man to each pair of wheels to open or close them. At each lift the tube is raised six feet. The cylinder, within which the ram works, is 3 feet 1½ inches in diameter, outside measure; and the hollow for the ram is 1 foot 8 inches in diameter.

The cross-head is 9 feet 10 inches wide, and 2 feet 5½ inches deep; the apertures for the guide-rods are 6 inches in diameter, and those for the chains are 2 feet 1 inch long, by 1 foot 1½ inch wide. The guide-rods are 11 feet 3½ inches long between the cylinder of the ram and the cross-head.

The case of the cylinder is not square in plan, but is longer than broad, being 5 feet 2 inches in length, by 3 feet 9 inches in width; and strong ribs spring from the corners and longest sides to strengthen it.

The space allowed for water is very narrow all round the ram, and there is a deep collar at the top of the cylinder, at which part the space for water is stopped, and a water-tight joint is formed by means of a leather packing in it.

The aperture for the entrance of the water into the cylinder is bored through the collar, and is only three-eighths of an inch in diameter; and the quantity of water each cylinder will hold is 66 gallons.

Each press, being 18 inches diameter, equals 324 circular inches; and, being worked under a pressure of 3 tons per inch, will lift 972 tons; but it is calculated they would bear four tons per inch, and be capable of supporting the enormous weight of 1296 tons. The Con-

way tube is about 1300 tons weight, and each ram, therefore, has to lift but 650 tons.

The water is forced into the cylinders by means of steam engines fixed between the vacant piers, on which the second tube will ere long be placed. The engines are on the high-pressure principle, with the cylinder placed horizontally. The piston-rod passes through stuffing-boxes at each end of the cylinder; a cross-head is connected to the piston-rod, giving motion, by side rods and cranks, to two fly-wheels, one placed on each side of the engine. Into the piston-rod, at each end, the plungers of the forcing pumps are fixed, having a stroke equal to the stroke of the steam piston. The steam piston is 17 inches in diameter; the plunger of the pumps $1\frac{1}{16}$ inch diameter; and the length of the stroke is 16 inches. The boilers are on the tubular principle, somewhat like those of the locomotive engine, but without circular fire-places. The whole being very portable, is fixed on a frame-work of wood with very little trouble.

On the 6th ult. the labor of raising this vast tube was very nearly accomplished. The tube, which at first was resting on part of the platform on which it was built, was raised eight inches by pumping the water out of the pontoons, which had been placed under it. At about eleven (the tide still on the flow) the whole fabric was got under weigh, and slowly drawn down by means of hawsers attached to various convenient places, and worked by capstans, until it arrived within a few feet of its proper position at the north side, and in its right position at the south, or Conway side, when, owing to the pontoons on that side touching the bottom, it could be got no farther, and the tide receding, the tube was left unsupported on the two temporary stone-beds, built inside the abutments. With this single, and, indeed, trivial, exception, the whole operation was performed in a most satisfactory manner.

The tube was floated to the piers on six huge pontoons, three at either end, constructed near the spot where the tube was erected. The pontoons are 100 feet in length, 25 feet in width, and 10 feet high.

The pontoons were floated under the platform on which the tube rested at low water; and the piles supporting the platform being taken away, the whole mass of the tube rested upon two stone piers, temporarily erected at either end for that purpose; but as the tide rose, the pontoons lifted the tube from these piers, and transported it to the shelf prepared for it below the presses on the permanent piers. The tube bridge floated with the greatest ease, and not submersing the 6 pontoons on which it rested (three at either end) to within at least 3 ft. of their decks. The precautions taken by Captain Claxton, R. N., to whose sole direction the transporting of this enormous mass was committed, were contrived to keep the machine suspended over its fixed piers, to await, as it were, the decision of the engineer as to whether the perilous step of launching into the deep (for the river is 12 fms. at low water) should be proceeded with; or whether the valves should be lifted, and the tube dropped, as it were, again in place, upon its piers, many circumstances appearing to bear upon that determination —the strength of the current, the height to which the tide promised

by its comparative rising, and the strength of the wind. The tide however, appeared to slack, and the resolution was formed, for the chains and ropes were hove upon, and in ten minutes it had passed the first rubicon—gradually, but steadily, it approached the site intended for it. In the pontoons, three enormous masses of timber, 95 ft. long by 25 ft. wide, and 8 ft. deep, bound together with powerful crabs, worked by 44 men, hove upon the chains, which had previously been tightened up by a large crab, at which a dozen or more men strained with their utmost efforts at either end on shore—one end of each chain being fixed at the piers of the suspension bridge, while the other ends were fast to the crabs, on the opposite side of the river; on these chains the pontoons appeared to traverse. The western, or Conway end, was pointed first, but did not come quite home afterwards. The eastern, or Chester end, was dropt in after, or while the ebb was making, but before it reached, by about a dozen feet, the exact berth, it took the mason work, and no effort could disengage it. Nevertheless, it was over its bed, sufficiently to be landed and bedded up with timber previously prepared from a lower bed, which had been provided in case the tide should fall before the upper bed could be reached. The most extraordinary efforts were made, with screws and tackles, no less than four of which latter were at one time applied, besides the Chester side crab, manned by sixty people, while the tide was falling, to overcome the obstacle; but they appeared to be ineffectual, and Captain Claxton gave orders for bedding up, which was speedily accomplished. The barges were then sunk a little, and the fabric rested very near the hydraulic presses which are to be used in raising it. Three steamers were in attendance below the bridge, two full of company, and a great number of boats plied with their freights on the river. The way in which, in a tideway never really still, this enormous structure was placed upon its bed, reflects the greatest credit on all concerned, down to the lowest laborers. All seemed to be excited and actuated by the liveliest desire for success. We were told that eighty men were in each set of pontoons—one set commanded by Captain Dunce, R. N., an assistant of Mr. Brunel, and the other set by Lieutenant Blatchly, R. N.; the crews under them, performing the principal work, being sailors from the Home of Liverpool, of whose admirable conduct in Conway we heard high encomiums. In the tube, attending the hawsers, were the officers and some of the crew of the *Great Britain*. On the top, on the Conway side, Mr. Fairbairn, of Manchester, had the direction; and, on the Chester side, Lieut. Glenny, R. N. The great difficulty to be overcome was apparent—the space to play in; for, on the Conway side, it wants nine inches, by actual admeasurement of our correspondent, of being home, or in place; while on the Chester side, it is fairly jambed against the masonry, so, that, in fact, there were barely 9 inches free in 400 feet. No sooner had the tide fallen sufficiently, than the obstacle to the exact fixing in position became apparent to all. The inner pontoon was butting at its end against and partly upon a rock. It took the ground which had been blasted away from the solid rock—in conse-

quence of having got a little twisted previously to starting, we were assured, full 4 feet.

Since writing the above description, we have the gratification of announcing that the tubular bridge has been safely lodged in its proper position on the lower piers of masonry—and is now most admirably adjusted for the attachment of the chains, by which it will be lifted into its permanent resting-place. The tube was again floated by means of the pontoons, in the presence of Mr. Stephenson, Mr. Fairbairn, Captain Claxton, and the other engineers and nautical gentlemen who have throughout directed the operations. Both Mr. Stephenson and Mr. Fairbairn have been incessantly occupied at Conway since the commencement of the operations; and we may safely congratulate both those gentlemen, and the profession generally, on this successful accomplishment of the greatest engineering triumph ever attempted. It is expected that the line of railway will be opened from Chester to Bangor in the course of the ensuing month. London Artizan.

Gauge-pipe, or Apparatus for Measuring the Constant or Variable Product of a Flow of Water, during any given time.

A report from Messrs. Poncelet, Piobert, and Morin, reporter,—a committee of the French Academy of Sciences, appointed on a memoir relative to this subject by M. A. Lapointe, is contained in the "*Comptes Rendus*" of November 2, 1847. The importance of this subject, in the application of water as a moving power for machinery, or other practical purposes, will be understood by all who are aware of the difficulty of ascertaining, with the requisite degree of precision, the quantity of water expended under variable circumstances, during a given period of time. The different results produced by a particular arrangement of the apertures; a change of rapidity in the revolutions of the wheels; a variation of the level in the head and fall; and other modifying causes,—are such as to show that it is by no means easy exactly to appreciate them in experiments upon the effect of water power.

An apparatus which would, by the mere inspection of an index, and the application of a simple form of calculation, give at once the quantity of water flowing through a known orifice, in a given time, would be a contrivance of great utility to engineers and others charged with, or interested in, the application of hydraulic science to ascertain practical effects. Many attempts have been made to solve this problem, most of which have been directed to the determination of the mean velocity of the fluid in a section of known surface, thence deducing the volume of the flow. M. Lapointe proposes to ascertain immediately, and without other measurement than the inspection of an index, the quantity of water flowing through any aperture, and under all circumstances.

According to the description given by the committee, the apparatus used by him consisted of a cylindrical pipe, furnished with a little wheel with helicoid wings, the axis of which corresponded with that

of the pipe, and which gave motion to an index placed above the water, and within sight of the observer. The tube, widened at its mouth in a form similar to that of the contracted vein issuing from a circular aperture, is fastened, by means of a flanch and bolts, to the dam of plank which prevents the passage of any water except through the pipe. The axis of this pipe is horizontal, and it is placed so low that its upper edge may be always beneath the level of the water below the dam, which will, in all cases, ensure a full flow from it.

The wheel is placed in the axis of the pipe, and at such a distance from its mouth, that the parallelism of the filaments of water may be established by the time they reach it. The axle of the wheel imparts movement by a bevel gearing to a very light vertical spindle which rises from the pipe, above the level of the water, and moves an index, by which, when the apparatus is at work, the number of revolutions made by the wheel, in any given time, may be determined without stopping or changing the motion.

It will be readily perceived that when there is a difference of level between the water on opposite sides of the dam, there will be a current passing through the pipe, and that the wheel will begin to turn so soon as the action of the current overcomes the passive resistance of the apparatus. The velocity of the wings, or the number of revolutions made by the wheel, increases, then, with the difference of level, or with the expenditure of water, according to a law which was left to be determined, by direct experiments, whether it was sufficiently simple to render the application convenient and certain.

For this purpose M. Lapointe made the following experiments at one of the races of the powder works at Bouchet. The outlet of the face, where it emptied into the general canal of discharge, was closed by a dam of planks, in which were made three apertures, each being three-tenths of a metre square, and encased with sheet iron. Gates, also of sheet iron, were worked by screws, so as to allow, in each experiment, of the passage of all the water which presented itself, and thus to maintain a constant level above the bottom of the orifices. The flow through these apertures, the edges of which were sharp,—the contraction complete entirely around them, and which were very similar in arrangement and dimensions to the apertures studied by Messrs Poncelet and Lesbros,—may be estimated by the results obtained by these practised observers.

The gauge tube was placed in another dam, at a sufficient distance from the former, and above which a constant level was established and maintained during each experiment.

The control and constancy of the levels being thus acquired and ascertained, it was certain that the gauge pipe and the little measuring gates delivered equal volumes of water in the same period of time. One of the observers remained near the little gates, to be certain that the level was constantly maintained; while the other took post at the gauge pipe, to observe the number of revolutions made by the wheel per minute; using for that purpose one of Breguet's counters.

In the first experiments, of which the results are given by M. Lapointe in his memoir, he operated in this manner with constant levels:

the differences in the height of water above the dam, and that below it, being comprised between ·06 and ·24 metres.

Now, taking for abscissas the volumes of water expended in a second, and for ordinates the corresponding number of revolutions of the wheel,—he has shown that all the points thus determined fall upon the same straight line, which intersects the axis of the abscissas in advance of the origin of the co-ordinates. From which he concludes: 1. That the movement of the wheel does not commence unless there flows, in a unit of time, a certain volume of water: and, 2, That for the different volumes of water discharged in a unit of time, the increase in the number of revolutions of the wheel is proportional to the increase in the volumes expended.

The law, therefore, which connects the number of revolutions with the corresponding volumes of water expended in a unit of time, may, when the rule is established, be represented by the simple equation of a right line, $Q = a + bn$;—in which Q represents the quantity of water discharged in a second;—a and b the constant numbers furnished by the observations, and which, for the wheel used, have the following vaues: $a = ·0635$ cubic metres; $b = ·01247$ cubic metres;—and n the lnumber of revolutions in a second.

In comparing the results of this practical formula, $Q = ·0635$ cubic metres $+ ·01247\ n$, with those of the direct observations, it was found that the greatest variation of the result of the formula from that which was furnished by the observations at the gates, was $\frac{1}{40}$ of the latter; and this difference, which is sometimes in excess and sometimes in defect, should be rather attributed to errors of observation at the gates, than to the instrument itself.

It was therefore established, by these first experiments, in which the volumes discharged per second varied from ·131 to ·372 cubic metres, that, when the discharging and receiving levels continued constant, the above formula will enable us directly to calculate the expenditure, by knowing the number of revolutions made by the wheel. But as in these experiments the operations were successively conducted at different velocities, it was natural thence to conclude that the relation between the velocity of the water, or the expenditure, and the number of turns of the wheel, was independent of that velocity,—or, that the co-efficients a and b of the formula were independent of the velocity;—and that consequently this formula ought to apply, with the same accuracy, to the measuring of water when the velocity was variable, as when it was permanent. This last consideration greatly extended the utility of the gauge pipe, inasmuch as it rendered easy the measurements under variable levels, and enabled observers to avoid one of the principal causes of error in experiments upon water power.

However plausible might be this conclusion which M. Lapointe had drawn from his first experiments, he rightly conceived that it was necessary to verify it by special experiments. For this purpose, and in order at the same time to extend the field of his observations, he obtained from the able engineers who have the direction of the Paris water works, authority to fix his apparatus between two of the great

basins of Chaillot, the regular form of which is favorable to gauging by direct measurement of the volumes.

A trench of 1·40 metres in width, by 1·80 in depth, was made between the two reservoirs, and extended in the lower basin by a wooden trunk of the same size and about five metres in length; making the total length of the conduit about nine metres. At the entrance of this conduit is a gate, by means of which the flow of water from the upper to the lower basin may be regulated at pleasure. Below this gate was placed the dam to which was attached the gauge pipe previously employed at Bouchet. A second dam, placed at the outlet of the conduit, allowed the water of the lower level to be kept at a convenient height above the extremity of the pipe. The water which passed over the dam fell into a trough, in which were placed inclined planes to conduct the water down gently, that it might fall into the basin without causing too great an agitation of the surface.

A wooden float, so large as to be little affected by the waves on the surface of the water, sliding on a rod graduated to every five centimetres, was used for determining the elevation of the level.

The steam pump at Chaillot raises but about 140 litres of water in a second; but, on account of the excess accumulated in the reservoir, much more than this quantity could be used in operating with variable heads of water. At the commencement of a series of experiments, the upper basin was full, and the lower one almost empty; there was then a strong head, and the pipe discharged more than the pump supplied; in consequence of which the level above the pipe was reduced, as well as that below it; but the former more than the latter. The moving power, therefore, being equal to the difference of the levels, was constantly diminishing, until the pipe discharged but about 140 litres,—the flow and the supply being then brought to a permanent condition.

Ingenious arrangements having been made to that effect by the author, the observations of the height of level in the lower basin,—of the corresponding time,—and of the index showing the number of revolutions performed by the wheel,—were all made readily and simultaneously by the same person. In order to account for the difference in the values obtained for the constants of the formula in these experiments, it should be observed that the wheel and index used, had been altered in their proportions from those used in the first experiment.

These new experiments, to the number of 68, made under conditions of movement varied with the heads of water giving the velocity comprised between ·01 and ·435 metres, were graphically represented like the preceding, and in like manner showed that the relation between the volumes of water expended, and the number of revolutions of the wheel, is expressed by the equation of a right line. But here, in consequence of the changes made in the proportions of the wheel and the index, the values of the constant coefficients of this equation are $a = ·024$, and $b = ·02203$ cubic metres, which leads to the practical formula for calculating the flow per second, $Q = ·024 + ·02203\ n$; or, if the observation be continued during a period express-

ed in seconds by t, then $Q = \cdot 024\ t + \cdot 02203\ n$, in this case n being the whole number of revolutions during the time t. The discharges observed having been comprised between 77 and 423 litres in a second, it will be perceived that they varied nearly in the ratio of 1 to 5·5.

Two of the committee caused several of the experiments to be repeated. These were made indiscriminately with full and medium heads of water, and the results obtained agreed perfectly with those observed by M. Lapointe.

Another gauge pipe, intended for the discharge of a larger quantity of water, with a diameter of ·70 of a metre, was also tried at the basins of Chaillot. A series of 33 experiments, in which the difference between the upper and lower levels varied from ·03 to ·23 of a metre, and the expenditure from ·8158 to ·2338 cubic metres verified anew the proportionality of the discharges to the expression of the form $a + bn$. The graphic representation of the results gives for the constants a and b, the values $a = \cdot 014$, and $b = \cdot 0478$ cubic metres,—and consequently, for the practical formula, $Q = \cdot 014 + \cdot 0478\ n$.

The general result of these experiments is, that the gauge pipe, wheel, and index of M. Lapointe, furnish a simple, expeditious, and accurate means of determining the quantity of water which passes through the tube, either under constant or variable heads. Its application is not more difficult than that of any other method of measuring by dams, and is not subject to the same uncertainty. When the tare of the instrument has been once carefully established, it will at once give the volume of water desired to be known.

The diameter of the pipe being only limited to a size which will admit of being readily placed in the proper position; it will be perceived that by means of one or two pipes of this kind, streams of water may be measured which deliver several cubic metres per second. Such an apparatus would be of great utility in experiments relative to the employing of water power, in situations where the measurement is attended with many difficulties, and occasionally gives rise to disputes. But whatever care the author may have bestowed upon the determination of the practical formula, by the aid of which the discharge is computed, it is proper that this determination, which consists in what may be called the *tare* of the instrument, might be examined and verified in the presence of the parties interested, if there is a question in dispute;—and to this effect the author proposes to study the ratio which connects the number of revolutions with the pressure of the head of water in constant levels, by which he will be able to make this verification.

It was suggested by one of the committee, that a highly useful application of M. Lapointe's apparatus might be made by employing the wheel and index themselves, to limit and regulate the volume of water discharged by the pipe, independent of the time and the variation of level. Thus modified, the apparatus would become a real *water meter*, which would be of important service in the supply and distribution of water to cities; and above all, in cases where water is to be shared or divided between parties.

On the whole, the committee conclude that the gauge pipe of M.

Lapointe is convenient in practice, and that it supplies a quick and sufficiently exact means of measuring the flow of a stream; and therefore propose that it should receive the approbation of the Academy. The conclusions of the report were adopted.

For the Journal of the Franklin Institute.

An account of the Explosion of the Locomotive "Engineer," on the Reading Railroad. An Extract from a Letter.

The "Engineer" engine, belonging to the repairing department, started early on Monday morning, May 1st, from Pottstown, with a train of cars loaded with materials for distribution upon the line. When she left Pottstown, she was in charge of the fireman of the "Rocket" engine, named Christopher Gaffney, who proceeded as far as Reading, where the regular engineer of the Rocket, Wm. Nagle, was waiting to take charge of her. The reason why the fireman had charge of her from Pottstown to Reading, was, that Nagle, the regular engineer, had his family residing in Reading, and was in the habit of visiting them almost every Saturday evening, and spending Sunday with them, and on Monday morning would take charge of his engine as she passed Reading, as was the case on the morning of the accident.

Gaffney was considered a good man, and had frequently run engines for a week at a time, when anything occurred to make an extra engine necessary in that department.

The reasons why the engineers were changed, are simply these:—The "Rocket" engine, of which Wm. Nagle was the engineer, required some repairing to be done to her. She was taken into the shop under the direction of Wm. Sessford, engineer of the "Engineer" engine, who was considered a better mechanic, and had been in the habit of attending to all repairs of machinery in that department, although he was not considered a better engineer. While Sessford attended to the repairs of the "Rocket," Nagle was transferred to the "Engineer" engine, who had frequently run her, and other engines before, under similar circumstances.

When the "Engineer" left Pottstown, she had a train of eight eight-wheeled platform cars, lightly loaded with materials. She was blowing off freely, as was usually the case with her when starting, as she made steam fast while standing still. She was hot, but not dangerously so. She stopped several times between Pottstown and Reading, to unload materials, and when she arrived at Reading, she was not observed to blow off in a very remarkable manner, nor did she appear very hot. She stopped at the Reading station, about ten minutes, to take in wood and water, and then proceeded without any cause of alarm, on her way up the line. When about half a mile above the station, the explosion took place. The cause of the explosion is attributed to the low state of water, when she arrived at the Reading station, which is supposed to have caused the crown sheet of the fire box to become very much heated, and the pressure upon it being so great, that it forced it to give way.

There are other reasons given, causing the explosion—such as im-

perfection of the work, &c., but the opinion of those with whom I had conversation about this matter, and who I consider more conversant on the subject, agree that it was owing to the low state of water, when she arrived at Reading; and I have no doubt, if the matter was properly investigated, it would prove similar to that of the Neversink.

The engine was running backward at the time, and her position to the train, was, with her front or bumper attached to the cars, placing the tank of the engine at the head of the train. Her safety valve was found after the explosion, set at 80 lbs. to the square inch. The engine was not much shattered, but was thrown across the other track.

This, then, is all that I can give you in regard to this dreadful calamity, as both the engineer and fireman were killed by the explosion, who alone could have furnished us with a correct account, had their lives been spared. But as it is, we must attribute it to the most reasonable cause, although something else might have been the cause of the explosion.

Amount of Railroads in the United States.

It appears by a calculation made by a gentleman of this city, who has given much attention to the subject of our railroads, that before the taking of the next census, (two years hence,) there will be 6000 miles of railroad completed in the Atlantic States, north of the Potomac, of which, upwards of one-half lie east of the Hudson river. In this computation, the coal and quarry lateral railroads are included, but the withdrawal of these will not make any important deduction in the amount.

The Wear of Cast-Iron Rails.

I have had an opportunity of ascertaining, in the case of a railroad over which 200,000 tons weight were conveyed annually, during a period of eighteen years, (comprising the carriages and their loadings of coals in one direction—viz.: 150,000 tons; and the empty wagons only in the other—viz.: 50,000 tons,) that the mechanical waste from attrition was 1 lb. in every lineal foot of rail, (2 lbs. per foot of way,) or thereabouts, in the course of the time named, which is 587 lbs. per mile of road per annum, the rails being cast from cold-blast pig-iron. It may not be generally known, but I believe it to be true, that there is no chemical waste going on with rails in regular use—a certain degree of heat, occasioned by the loads passing over them, preventing oxidation. The wear of hot blast cast-iron rails will be considerably greater, and by breakage still more; it is, indeed, a very difficult matter to assign to them a competent weight and strength—one-half more metal, would, I much doubt, scarcely be sufficient for the purpose. I do not think it has yet been satisfactorily shown what the loss in weight, by wear, of malleable iron rails is, but it cannot fail to be considerably less than that of cast-iron. It is, indeed, a fact well known, and supported by theory, that the more highly iron is wrought, and the purer it is rendered, by being purged of earthy dross in its

transmutation from the crystaline to the fibrous state, the stronger and more durable it will be, whether as regards its subjection to the action of fire, to attrition, or mechanical stress—in the character of engine grate bars, wagon way-rails, tye bars, &c.—*Thompson's Colliery Inventions and Improvements.* Lond. Mech. Mag.

List of American Patents which issued in the month of March, 1847, with Exemplifications, by CHARLES M. KELLER, *late Chief Examiner of Patents, in the U. S. Patent Office.*

1. For an *Improvement in the manufacture of Welded Iron Tubes;* Thomas Henry Russel, of Great Britain, March 6.

This is for an improvement in the method of welding iron tubes by the pressure of rollers. As heretofore done, the pressure to which the tube was exposed for welding, tended to separate the joint. To avoid this, the under roller is dispensed with, and instead thereof a rod is inserted within the tube, and called the beak, and this is bent up and enlarged at the forward end to form a rest against which the seam rests while under the pressure of the roller.

Claim.—"I claim the pressure roller which makes pressure on the cap joint for welding, in combination with the beak that resists the pressure of the rollers; when this beak is made of less diameter than the inside of the tube, and bent upwards to sustain the lap joint under the roller substantially as described, whether it be sustained by its attachment at the outer end alone, or by the under rollers as described, and placed between the point of the beak and its attachment."

2. For an *Improvement in Folding and Measuring Cloth;* Elbridge G. Woodman, North Chelmsford, Middlesex county, Massachusetts, March 6.

We are under the necessity of omitting the claim as it could not be understood without the drawings.

3. For an *Improvement in Folding and Measuring Cloth;* Arnold R. Austen (assignor of Simon D. Glines), Providence, Rhode Island, March 6.

Claim.—"I claim as my invention the employment of a horizontal sliding lathe, with measuring and folding scales or bars that fold and deposit the cloth in layers of one yard or any other exact measure, also the use of *receivers* or *holders* that operate in connexion with the sliding lathe to receive and firmly hold from slipping, the successive layers of cloth as they are distributed by the folding scales.

"Also the use of a compressible bed or platform on which the cloth is deposited, that operating in connexion with the sliding scales and receivers, shall gradually lower to make room for the cloth as it is folded thereon."

4. For an *Improvement in Ploughs;* Emanuel Albert, East Germantown, Wayne county, Indiana, March 6.

The patentee says,—"The nature of my invention consists in the following arrangement, viz: to have at the upper part of the mould-board and guard-plate, cast solid with the same, flanches in right angle, —the one to the right, the other to the left, in a manner, that when the mould-board and guard-plate are fitted together, the flanch of the one to be covered by the flanch of the other, and permanently fastened together by a screw bolt."

Claim.—"What I claim as my invention, and desire to secure by letters patent, are the two flanches which connect together by the screw bolt permanently the flanch of the mould-board with the flanch of the guard-plate, as described."

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5. For an *Improvement in Coal Stoves;* John T. Davy, Troy, Rensalaer county, New York, March 6.

This invention relates to the manner in which the smoke, &c., is conducted from the fire, and the arrangement of the flues incident thereto.

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the combination and arrangement of the flues with the cylinder, so as to take the draft off on each side, directly at the top of the fire, and cause it to descend, thence ascend the corner flues, as described, the stove having an opening in the top for fuel as set forth."

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6. For an *Improvement in Planing, Tonguing, Grooving, &c., Plank;* John Cumberland, Mobile, Alabama, March 6.

The patentee says,—"The nature of my invention consists in passing the board or plank to be reduced and planed first under a roller or rollers, whose surface is composed of a series of sharp edges, parallel with the axis, to form cutters, which, in rolling over the board, makes cuts in its surface of the required depth, and at distances apart equal to the spaces between the cutting edges; and then in shaving off the projections thus formed by means of one or more plane irons, leaving the surface smooth, whether these operations be performed by carrying the roller or rollers and plane or planes over the board or plank placed on a permanent platform, or whether this be fixed or connected with a permanent frame and the board or plank be carried to and by them by means of a carriage."

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the method of reducing boards to equal thicknesses, or widths, by passing them under the action of cutting or scoring wheels, which cut into the surface, substantially as herein described, when this is combined with another cutter or cutters, which cuts off the parts scored or indented, substantially as herein described.

"And I also claim in combination with this, a smoothing plane or planes for smoothing or shaving the surface, substantially as herein

described. And I wish it to be understood that I claim this method of reducing and planing plank, or boards, &c., whether for planing the surface, tonguing, or grooving, or cutting mouldings."

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7. For an *Improvement in Hanging Carriage Bodies;* John Maxson, De Ruyter, Madison county, New York, March 6.

Claim.—"What I claim as my invention, and desire to secure by letters patent, is, arranging the helicle springs that support the carriage horizontally and lengthwise along the bottom of the carriage, when this is employed in combination with the four levers having their arms at right angles, or nearly so, to form the connexion between the springs and carriage body, and frame of the running gear, the whole being constructed and arranged substantially as herein set forth."

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8. For an *Improvement in Cotton Cleaners*; Robert M. Livingston, City of Mobile, Alabama, March 6.

Claim.—"What I claim as my invention and improvement, and for which I desire the exclusive privilege and right, is for the application of any kind of net or open work material, affixed upon arms radiating from a shaft, to act as a beater or beaters, either with or without a fanner, in the cleaning of cotton, &c."

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9. For an *Improvement in Steamboats, and Propellers therefor;* Stephen J. Gold, Cornwall, Litchfield county, Connecticut, March 6.

Claim.—"What I claim as my invention, and desire to secure by letters patent, is, first, the employment of side wheels having their shafts parallel with the line of motion, with narrow short paddles in an oblique position on the periphery of the wheel, and all the radial lines of which are perpendicular to the shaft, constructed substantially as herein set forth, and so arranged as to dip the paddle only into the water, in the manner and for the purpose described, the paddles being made to enter and leave the water without obstruction, and with sufficient velocity to prevent putting it in motion, before leaving it, enough to impede the progress of the boat, as above specified.

"Secondly, I claim placing two or more wheels on the same shaft, constructed as above set forth, the lead or angle of the paddles of the rear wheels being increased as herein described.

"Lastly, I claim forming the wheel with two or more arms, projecting down to the periphery of each of the stationary paddles, said arms being embraced by the paddles, which are made in two parts for that purpose, so as to present no obstruction to their passage through the water, while the strength and lightness of construction are fully preserved, and the paddles are perfectly braced."

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10. For an *Improvement in Horse Powers;* Jesse Urmy, Wilmington, Newcastle county, Delaware, March 6.

Claim.—"What I claim as my invention, and desire to secure by

letters patent, is constructing the links of the endless chain of a horse power in the manner described, so that they form firm connexions and a permanent axle for the friction rollers, while at the same time they constitute the rack by which the power is transmitted, substantially as set forth, by which means the use of axles extending through from side to side is dispensed with, while the advantage of the rollers attached to the platform is retained, forming a cheap and efficient horse power."

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11. For an *Improvement in Wheels for Railroad Cars;* Godlove K. Kane, York, York county, Pennsylvania, March 6.

Claim.—"What I claim as my invention, and desire to secure by letters patent, is making the spokes which unite the hub and rim of railroad car wheels, each of a plate, one portion of which is parallel with the axis of the hub, and extending from the hub to the rim, and the other connected with the rim, in a line diagonal with the plane of the wheel, and extending from the rim to the hub, the first gradually diminishing in width from the hub to the rim, and the other gradually diminishing from the rim to the hub, substantially in the manner and for the purpose described."

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12. For an *Improvement in Cutting Corks;* Philip C. Traver, Newburgh, Orange county, New York, March 6.

The patentee says,—"The nature of my invention consists in cutting corks in the form of a frustrum of a cone, or cylinder, from a sheet of cork (fed by hand or machinery) by means of a cutter fastened to the periphery of a hollow mandrel having a compound longitudinal and rotary motion around a centre or axis of a cylindrical sliding holder, inserted into a corresponding aperture in the mandrel, and bearing upon the sheet of cork, in which hollow mandrel is placed a spiral spring, bearing against the upper end of the holder, the lower end of the holder, guiding the cutter at the required angle to give the required taper to the cork."

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the before-described mode of cutting corks, by means of the aforesaid combination of the hollow mandrel, sliding holder, centerer, and guide—with the cutter for cutting the cork to the required shape—said cutter having a simultaneous, longitudinal, and revolving motion produced by the means described, or other more suitable means, operating substantially in the manner set forth."

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13. For an *Improvement in Refining Pine Oil or Spirits of Turpentine;* Norris L. Martin, Brooklyn, New York, March 13.

Claim.—"I claim refining spirits of turpentine or pine oil, by the use of alkali and water, substantially in the manner set forth."

14. For an *Improvement in Weaving Wire for Screens, &c.;* Henry Jenkins, Pottsville, Schuylkill county, Pennsylvania, March 6.

Claim.—"I claim as my invention, the apparatus described for weaving the screens from wire so crinkled; said weaving apparatus consisting in the combination of the stretching frame, or blocks, and screws, with the sliding frame, the harness and the sleigh which are attached to the said frame, the whole of which are made to advance from one end to the other of the loom, by means of the lever and its appendages."

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15. For an *Improvement in the manufacture of Screens or Sieves;* Henry Jenkins, Pottsville, Schuylkill county, Pennsylvania, March 6.

Claim.—"What I claim therefore as constituting my invention, and desire to secure by letters patent, is the manufacture of screens, or sieves, from wire of the larger sizes, either rolled or drawn; the wire from which they are made being prepared by crinkling, as set forth, previously to its being formed into meshes, by which procedure I am enabled to manufacture screens with meshes of the largest sizes, say four inches on the side, more or less, and in such manner as that they shall be more durable, and less costly, than those made in the other ways; and this new manufacture of sieves I claim independently of the particular manner of effecting the crinkling, or of interweaving the wire so as to form the requisite meshes."

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16. For an *Improvement in the Steam Cotton Press;* P. G. Gardiner, City of New York, March 13 (antedated 13 January).

The patentee says,—"The nature of my invention consists principally in the combination of the platten with the piston rod of a vertical steam cylinder, by means of double toggle-joint levers, and connecting rods, in the manner set forth."

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the connecting of the platten with the piston rod through the medium of the toggle-joint levers and the suspension rods; arranged, combined, and operating with each other, and with the wings in such a manner as to bring the reaction of the levers principally upon the cylinder, and the bed piece, substantially as set forth."

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17. For an *Improvement in Cleaning Cotton;* Rozell Needham, Memphis, Shelly county, Tennessee, March 13 (antedated December 21, 1846).

Claim.—"What I claim as new, and desire to secure by letters patent, is the combination of the adjustable hatchel and the skeleton cylinder with each other, and with the rotating beating wings and adjustable open concaves, substantially in the manner and for the purpose set forth."

18. For an *Improvement in Rack Wrenches;* Zelotus W. Avery (assignor of Benjamin Webb), New Berlin, Chenango county, New York, March 13.

The patentee declares,—"The nature of his invention and improvement to consist in forming the wrench with a cylindrical chamber in its largest end, extending entirely through it, having a circular seat formed around the same for the reception of a number of cylindrical revolving notched cores or nuts of uniform diameter, fitted to said circular seat, having a square or polygonal opening, in the centre of the same, corresponding with the size or shape of the nut or head of the screw to be turned, which is received into said square, or polygonal opening—the said nut being made to turn with the wrench when turned to the left, by means of a pall, attached to the wrench by a pin and spring, and engaged with a tooth of the nut—said pall, when the wrench is turned to the right, slipping back over one or more teeth of the nut without turning it, and being again engaged with another tooth of the nut, and the wrench again moved to the left, causing the nut to turn with it, and to turn the screw to which the nut is applied, and thus by a repetition of the aforesaid operation, causing the screw to turn as many times as may be required without disengaging the wrench therefrom, by simply moving the handle to the right and left in the arc of a circle, vertically, or horizontally, or obliquely, to any degree required, being adapted to the turning of any sized screw, by merely changing the cylindrical nut or core, without changing the wrench circle, and handle, and its appendages—the revolving notched nut or core being held down upon its seat in the circular chamber of the wrench, by a turning catch attached to the wrench and made to overlap the rim of the core or nut."

Claim.—"I claim as my invention, the peculiar mode or manner of adapting the wrench to the turning of screws, bolts, or nuts, or other articles, made with square, polygonal, or other shaped heads, by means of the changable cores, constructed as above set forth, and represented, in combination with the turning catch for holding the revolving core to its seat, as constructed and operated, as above described."

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19. For an *Improvement in Breaking and Cleaning Hemp;* F. P. Holcomb, New Castle, Delaware, March 13.

Claim.—"What I claim as my invention, and desire to secure by letters patent is, the combination of the stationary bed brake and the rotary brake, and small scutchers arranged in the manner described, so that the hemp can be fed in by hand, broken, and cleaned with but one handling and at one operation, the breaking and cleaning being done on separate cylinders, but the parts so arranged as that they are brought close together, and so adjusted as to only allow the machine to touch that part of the fibre that is to be acted on, thereby preventing its wear in the machine."

20. For an *Improvement in Boring Machines;* Jonathan Johnson, Mifflinburgh, Union county, Pennsylvania, March 13.

Claim.—"What I claim as my invention, and desire to secure by letters patent, is, the manner in which I operate and withdraw the auger and regulate the movement of the carriage, by means of the vibrating post and its arms and lateral projecting concave—the cam and pulley, upon the auger shaft—the pin and tooth, upon the pulley —the spring, the detent and pin, connected to each other,—the vibrating bar and weight—the whole arranged, combined, and operating with each other and with the notches in the side of the carriage, and the weight for moving the same substantially in the manner set forth."

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21. For an *Improvement in Turning, Cutting, and Splitting Stone;* Charles Wilson, Springfield, Hampden county, Massachusetts, March 13.

Claim.—"What I claim as my invention, and desire to secure by letters patent, is, the mode of cutting, turning, or splitting stone, or other like material, by means of a revolving cutter, operating in the manner herein set forth."

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22. For an *Improvement in Furnaces for producing Malleable Iron direct from the Ore;* Alexander Dickerson, Newark, Essex county, New Jersey, March 13.

Claim.—"What I claim as my invention, and desire to secure by letters patent, is, the method of making malleable iron direct from the ore, by combining a chamber containing the charge with a closed fire containing a continuation of the charge and the loop formed therein, arranged below and communicating with the same, provided with a suitable opening, closed by a door, for the introduction of a portion of the charge, and for excluding the air therefrom; and with movable bars for holding up the charge in the upper chamber whilst burning down the charge in the lower chamber and taking out the loop therefrom at the door, substantially as above described and set forth."

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23. For an *Improvement in Air-tight Stoves;* John S. Marll and William J. Ogden, Georgetown, District of Columbia, March 13.

Claim.—"What we claim as our invention, and desire to secure by letters patent, is, the arrangement of the hot air chamber and tubes in combination with the radiating pipes and division plate with its valves, substantially in the manner described."

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24. For an *Improvement in the Method of Producing Rectilinear Reciprocating Movements for Planing Machines, &c.;* Moses Ingalls, Burlington, Bradford county, Pennsylvania, March 13.

Claim.—"What I claim as my invention, and desire to secure by letters patent, is, the method, substantially as herein described, of

giving to the carriage a reciprocating rectilinear motion, in combination with the lateral motion at each end of its course, by means of the straight grooves in combination with the diagonal grooves at each end and the spring switches, substantially as described.

"And I also claim, in combination, the method, substantially as described, of giving the reciprocating motions of any desired extent, and greater than the circumference of the actuating pinion, by placing the two racks on each side of a plain at right angles to the axis of the pinion, in combination with the pinion, having cogs entirely around its circumference in the middle of its length, and segments of cogs on each side as described."

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25. For an *Improvement in Cast Iron Plough Clevises;* John Van Brocklin, Middleport, Niagara county, New York, March 13.

Claim.—"What I claim as my invention, and desire to secure by letters patent, is, the construction of a double-gaged, cast-iron clevis, substantially as described."

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26. For an *Improvement in Clocks;* John S. Greig, Walden, Orange county, New York, March 13.

Claim.—"What I claim as my invention, and desire to secure by letters patent, is, the pendulous plate, together with its ball or weight and the cylindrical stud."

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27. For an *Improvement in Combing Wool;* C. G. Sargent, Lowell. Middlesex county, Massachusetts, March 13.

We extract the following from the specification:—"The nature of my invention consists in attaching the comb teeth to a series of plates that are caused to slide along in front of the cylinder of cards, and a pair of rollers for the fibres to be acted upon, and stripped from the teeth, and then are shifted in a parallel position to slide back to the end from whence they first started, and there shifted back to pass along as at first; a hollow box through which steam or heated air circulates being placed between the comb teeth and the cylinder of cards, and a little below the points of the comb teeth, for the purpose of keeping the fibres at the required temperature while under operation in the machine."

Claim.—"What I claim, therefore, as my invention, and desire to secure by letters patent, is, making the series of plates that carry the comb teeth continuous in their action by transferring them at each end from one groove or set of ways to another, and back again, substantially as herein described."

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28. For an *Improvement in Shirt Bosoms;* Madelin Tassie, Brooklyn. King's county, New York, March 13.

Claim.—"What I claim as my invention and improvement, and desire to secure by letters patent, is, the self-adjusting quality or

property the bosom possesses by the addition and application of the yoke and elastic strap described, which belong to no other bosom."

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29. For an *Improvement in Looms for Weaving Brussels Carpeting;* Erastus B. Bigelow, Boston, Massachusetts, March 20.

We could not, without drawings, give a clearer idea of these improvements than will be derived from the following claim:

Claim.—"What I claim as my invention, and desire to secure by letters patent, is, giving to the two parts of the mechanism, that which weaves the cloth or forms the body of the fabric, and the one which operates the figuring wires, a separate and distinct organization, substantially as described, when these are connected and combined by an intermediate mechanism which shifts the motive or driving power from one to the other, substantially as described; and in combination with this, I also claim the employment of the two brakes to arrest the momentum of the moving parts to prevent any conflict in the operations of the two parts of the mechanism, as described."

"I also claim the method, substantially as above described, of taking the figuring wires and transferring them one by one to the apparatus which introduces them under the figuring warps, as described.

"And finally, I claim the method, substantially as described, of carrying and dropping the figuring wires under the figuring warps by means of a sliding box or its equivalent which supports the wire, as described."

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30. For an *Improvement in Looms;* James Haworth, Frankford, Philadelphia county, Pennsylvania, March 20.

The patentee says:—"My improvement is designed to remove the friction of the shuttle against the "*swett lever*," and thereby to reduce the power required to operate the loom.

"Beside the aforesaid object, I also, by my improvement, effect another important object, namely, running the loom backward or in a contrary direction, without the use of the shuttle, when the loom is not performing the operation of weaving."

Claim.—"What I claim as my invention, and desire to secure by letters patent, is, the mode of relieving the pressure of the swett lever against the "*shuttle*" by means of the combination of the additional finger with the *stop-rod* and *lathe-arm* and pin, or any other combination substantially the same."

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31. For an *Improvement in Preventing Explosions of Steam Boilers;* Alfred Stillman, City of New York, March 20.

The patentee says:—"The nature of my improvement consists in the use of a tube, one end of which is stopped by fusible metal, and rests upon some part of the boiler liable to be overheated from a deficiency of water, while the other end opens through the external part or shell of the boiler to allow the escape of steam to give alarm to the person

in attendance, whenever the fusible metal should become melted by the overheated boiler, and so arranged that the issue of steam may be stopped at pleasure, and the fusible metal subsequently restored to its place with very trifling labor or detention."

Claim.—"What I claim, and desire to secure by letters patent, is, the application to steam boilers of a tube, constructed for the purpose, or in the manner herein described, and stopped with a cap, or any other shaped piece of fusible metal resting upon a part of the boiler liable to become overheated in the absence of a proper supply of water, and designed for the purpose and objects herein substantially set forth."

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32. For an *Improvement in Knitting Machines;* Joseph Vickerstaff (assignor of A. Cummings and W. S. Haines), Philadelphia, Pennsylvania, March 20.

The nature of this invention consists in forming the loops from a series of warps, by means of a series of needles arranged in a circle, and parallel with each other, made to slide within a ring, that answers the purpose of a presser, so that the threads which are to form the new loops shall be caught under the beaks of the needles, before they are closed by the presser ring, to allow the previously formed loops to pass over and be cast off; the bobbins and guides being made to travel around the needles, or to vibrate back and forth alternately, according to the design of the figure to be produced.

Claim.—"What I claim as my invention, and desire to secure by letters patent, is, the arrangement of the needles in a circle, and parallel with each other, or nearly so, in combination with the pressure ring, by means of which the beaks of the needles are closed to hold the new, and cast off the previously formed loops, substantially as described; and this I claim in combination with the inner tube over which the woven fabric hangs, as herein described.

"I finally claim the rotary table which carries the warps and guides, in combination with the needles, arranged as described, whereby the warps can be carried around continuously in one direction, or alternately in opposite directions, for the purpose and in the manner, substantially as described."

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33. For an *Improvement in Steam Engines;* Wilson Eddy (assignor of S. Norris), Springfield, Massachusetts, March 20.

Claim.—"What I claim as new, and desire to secure by letters patent, is, the combining together of two cylinders, an exterior and an interior, as herein set forth; the exterior cylinder being permanently attached to the engine in the ordinary way, and the interior cylinder being removable at pleasure, as herein fully made known."

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34. For an *Improvement in Cut-off for Steam Engines;* Horatio Allen, City of New York, March 20.

Claim.—"What I claim in this improvement, is, placing the *fulcrum*

of the lever, which carries the cut-off slides, *on the rod* carrying the main valve, or on some part having the same motion as the main valve, substantially in the manner set forth."

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35. For an *Improvement in Steam Valves;* Henry H. Grame, City of New York, March 20.

The patentee says:—"The nature of my invention consists in the introduction of independent valves in the ordinary 'steam chest for sliding valves,' with means of connecting or disconnecting them to the slide valve, operating, when connected, in such a way as to prevent any further ingress of steam within the cylinder after the piston has passed through a certain part of its stroke, and when disconnected, allowing the steam to work through the whole stroke of the piston."

Claim.—What I claim as my invention, and desire to secure by letters patent, is, the peculiar manner of connecting and combining the cut-off valves with the main valve, the hooks, rockers, and the stops; the said several parts being contained within the steam chest and worked by the main valve, operating and combined in the manner and for the purpose set forth."

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36. For an *Improvement in Journal Boxes;* James Old, Pittsburg, Pennsylvania, March 20.

Claim.—"What I claim as my invention, and wish to secure by letters patent, is, the making of a frame, shell, or concave (for confining metals or alloys), by itself, separate from the box for journals of shafts in machinery, and using the same for lining the box, by fastening it in some way thereto, so that the same may be applied to every kind or shape of a box, whether of brads, iron, wood, or anything else, and on or to plain surfaces; and so that when it is worn out, it can be replaced thereon or thereto almost indefinitely by a new one, thereby causing a vast saving in the number and cost of boxes."

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37. For an *Improvement in Heating Ovens;* P. Grouville, L. U. Mouchet and E. Mouchet (assignees of B. Rodrigues), France, March 20.

The inventor says, in his specification:—"The nature of my invention consists in the employment of air as a vehicle to convey caloric to the oven from an air chamber heated by furnaces, so that the same air circulates from the air heating chamber, under and through the oven, and when it has been partly condensed and its specific gravity increased, by giving out its contained caloric, returns back, through another set of flues to the air heating chamber, there to be reheated, thus keeping up a constant circulation, from the air heating chamber, around, and through the oven, and back again to the air heating chamber, instead of heating ovens by the circulation of air heated on its passage through a heated chamber, around the oven, or through it, and then escaping into the atmosphere. And also in combining with the above mode of heating ovens, an arrangement of fire chambers

without grates and ash pits, and with an arrangement of flues and dampers for heating the air, and to assist in heating the oven, on the principle of returning the products of combustion to the fire chamber, that is fire chambers, flues, and dampers, so arranged that the products of combustion, by the closing of the dampers, are returned to the fire chambers to consume the combustible gases, &c., and to retain the heat within the furnaces and flues, except when an active combustion may be required. And also in so arranging the flues through which the smoke and other products of combustion pass as to increase the temperature of the air as it circulates through a series of passages, under the bottom of the oven to heat it, and thus increase its rarefaction, and cause it to ascend into the oven."

Claim.—"What we claim as our invention, and desire to secure by letters patent, is, the method described of heating ovens by the circulation of air through them from a heating chamber, combined with the oven by two sets of flues, one for the ascending current or currents, and the other for the descending current or currents, by means of which the air, after being heated, passes up through the oven, and becoming specifically heavier, than the ascending current or currents, by giving out a portion of its caloric, descends to the heating chamber to be again heated, and then again to pass up to, and through the oven, and so on; the hot air or heating chamber not being provided with any aperture for the admission of fresh air to it whilst in operation. And I also claim, in combination with the above mode of heating ovens, by the circulation of heated air through the oven, the arrangement of furnaces, flues, and dampers, as herein described, operating on the principle of the air-tight stove, by means of which combination, the desired temperature can be maintained within the oven at a small expenditure of fuel, whilst the apparatus possesses the capacity to attain the temperature required, as described. And we also claim arranging the main and return flues for the passage of the smoke and other products of combustion directly under the chamber through which the heated air circulates to heat the bottom of the oven, by means of which the rarefaction of the hot air is increased, to cause it to ascend into the oven, as herein described."

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38. For an *Improvement in Foot Stoves;* George H. Thatcher, Ballston, New York, March 20.

Claim.—"What I claim, is the peculiar construction of the apparatus for surrounding the feet with a thin stratum of heated water, as above described. And I claim in combination therewith, the adjustable heater, arranged and operated in the manner and for the purpose set forth."

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39. For an *Improvement in Pumps;* Ralph Bulkley, City of New York, March 20.

The patentee says,—"The nature of my invention consists in the application to, and combination with, vessels' stepped pumps, a verti-

cally applied indentation or indentations, on the *outer* surface of the pump, extending upwards from or near the lower end of the pump, to any required distance, about four or five feet, upwards, more or less. These indentations may be made by fluting, or by grooves, or by battons placed at suitable intervals; and these indentations may extend entirely around the pump, or around any required section of it. And *through the projections* so formed by fluting, grooving or by battons, *transverse indentations*, or orifices are to be made, sufficient to form a *communication* for water from *each* indentation to the others; and one or more of the *vertical* indentations are to extend to and communicate with, the *lower* or receiving *orifice of the pump;* and those *not* so communicating, are to have a *stop-water* at foot; leaving only the horizontal or transverse communications open; around these transverse fluted indentations, downward, in sections, or entire, including the main orifice, is to be applied, appended thereto, a metallic, or other covering, containing small *perforations*, so that water may pass through into the indentations on the outer surface of the pump, to the receiving orifice ; so that if the *covering* at the lower end of the pump should become "choked" or clogged by swelled grain, or otherwise, the *water* would rise upon the pump, until it found an *entrance* into the indentations or transverse flutes; and in the outer canals formed thereby, the water will pass *downwards* unobstructed, into the receiving orifice of the pump; the object of which is, to preserve an *unobstructed* passage for water to the orifice of the pump, though the lower *end* and *lower part* of the pump become "*choked*" and *clogged* with swelled grain or otherwise; a casualty of common occurrence, arising from a *variety of causes*, by which the pumps frequently, at times most needed, become *useless*, endangering life and property."

Claim.—"What I claim as my invention, and desire to secure by letters, is the application to, and combination with, vessels' pumps, the indentations and appendages connected therewith, as herein described, for the objects and purposes herein set forth, using, therefore, any description of material that will effect the object."

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40. For an *Improvement in Screening Grain;* John Bamborough, Lancaster, Pennsylvania, March 20.

The patentee says,—"The nature of my invention consists in the construction and arrangement of the screens for screening the grain from cockle, &c., and conveying it off separate from the grain, while it is susceptible of being converted into the common riddle fan at pleasure."

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the combination of the screens and cockle boards, arranged substantially in the manner and for the purpose set forth."

41. For an *Improvement in the Expansion Joint for Steam Engines;* Henry R. Dunham, New York, March 20.

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the application of a plate of flexible metal in a steam pipe between two flanches of different diameters, the yielding of which plate shall give sufficient room for the expansion of the pipe, thereby avoiding the necessity of using stuffing boxes, or the ordinary copper hemispherical ring joint, for side pipes of steam engines."

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42. For an *Improvement in Looms;* Lawrence Holmes, Anderson, Essex county, Massachusetts, March 27.

Claim.—"What I claim as my invention, is the peculiar manner of producing, by means of the jacquard apparatus, a double draught upon each of the harnesses; in other words, I claim the peculiar punches and bars (connected with the harnesses as described) as combined together, and with the remainder of the jacquard apparatus and with the harness, and constructed and operating therewith, substantially as described."

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43. For an *Improvement in Carriages;* A. W. Forward, Georgetown, Kentucky, March 27.

Claim.—"The improvement which I claim, and for which I desire letters patent, is the converting of a two horse carriage into a one horse carriage, by separating the fuchels, and the branch stays, which is done by removing the four bolts described."

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44. For an *Improvement in Furnace Bars;* John H. Fellows, Cincinnati, Ohio, March 27.

The patentee says,—"The nature of my invention consists in an improved furnace bar as follows, viz: first, the common bar is generally made flat on the surface, but the present invention has two longitudinal grooves, and a raised centre ridge between them. The grooves fill with ashes from the fire of either coals or wood, as the case may be, which being a nonconductor of heat, keeps the bar from melting, while the raised centre ridge must always keep the same cool. Second, the raised centre ridge always prevents the possibility of drawing the ashes out from the grooves in the bar, when clearing the fire with the poker, which is requisite to keep the space between the bars from filling up with clinkers, and thereby stopping the draught; hence, the ashes always remaining in the grooves, protected by the centre ridge, keep the middle of the bar cool. It cannot therefore warp or get out of its place, like the old bars. Third, in putting out the fires of either steam boats or land furnaces, which is desirable when the engine stops, to save fuel, and the time of the hands—bars frequently break down as soon as cold water is thrown on the fire—not so with the present invention; cold water thrown on them makes the bed of ashes firmer in the grooves, and the bars are not injured by

being suddenly cooled, like the common ones. Fourth, the bars now in general use are made double, so that when hot, should one side give way the other must follow. This is avoided by the present invention, being a single bar which also gives a further advantage, as they can be placed at any given distance from each other, so that by widening the space, give an additional draught, which is desirable, and more particularly with low furnaces."

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the application of two grooves and a central ridge to furnace bars, in the manner described above."

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45. For an *Improvement in Augers;* Alfred Newton, L. B. Smith, and E. Sanford, Meriden, N. Haven county, Connecticut, March 27.

Claim.—"What we claim as our improvement and invention, and desire to secure by letters patent, is the making or constructing double or single twist augers, with a gradually increasing length of twist, and consequent gradual enlargement of cavity, from the lower or cutting end to the other extremity of the twist."

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46. For an *Improvement in Pneumatic Hydraulic Engines;* Joseph C. Strode, East Bradford Township, Chester county, Pennsylvania, March 27.

We are informed by the patentee,—"The nature of this invention and improvement consists in making use of a column of condensed air between the propelling fluid, and the fluid that is to be raised—said air being condensed in a pyramidal shaped chamber, by means of the momentum of a descending column of water—said chamber having a communication by a small opening at its top with another chamber into which the spring water, or fluid to be raised, is introduced, called the spring water chamber, and upon which the condensed air in the first named chamber is made to act, causing said fluid to rise through a tube placed in the spring water chamber, (open at its lower end, and closed alternately at its upper end, by means of a valve,) into a large air vessel, or receiver, of the usual form and construction, being conducted thence to its place of destination, by pipes or hose, in the usual manner."

Claim.—"What I claim as my invention, and wish to secure by letters patent, is, first, making use of a column of condensed air between the propelling fluid—and the fluid to be raised in the manner above described, or other mode substantially the same by which analogous results are effected. Second, I claim the particular combination of the pyramidal air chamber, the internal spring water chamber, and the water tube with the curved conducting pipe and valve, and the air chamber and hinged valve, constructed and arranged in the manner and for the purpose substantially as set forth."

47. For an *Improvement in Bobbin Stands;* Noah C. Piram, Boston, Massachusetts, March 27.

The patentee says in his specification,—"My improvement in said stand consists in combining with it, and also with the cap piece, vertical lips or flanches, one of which is made to extend entirely around the lower head of the bobbin, and to rise up above the lower surface of the said head. The other flanch in a similar manner extends downwards from the cap plate, and around the upper head of the bobbin, and below the upper surface of the said head. The object of the said flanches is to prevent the twine on the bobbins from either passing between the lower surface of the lower head of the bobbin, and the upper surface of the base, or between the upper surface of the upper head of the bobbin, and the lower surface of the cap piece, as it very often does in the ordinary bobbin stand, and by so doing either becomes entangled, or so wedged between the surfaces in opposition, as to render it nearly, if not entirely impossible to rotate the bobbin, until the cause of the difficulty is removed."

Claim.—"What I claim, is the lip or flanch as applied to, or combined with, the base or cap piece, and arranged with respect to the bobbin, in the manner and for the purpose as above specified."

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48. For an *Improvement in Steam Engines;* Charles Galvani (assignor of John Clark), City of New York, March 27.

The patentee says:—"The nature of my invention consists in combining a rotary engine with an annular furnace, the revolving rim of the engine being heated so that when water is forced into it, it shall be flashed into steam which passes round through the cylinder and thence issues through an orifice on one side at a tangent to the wheel."

Claim.—"What I claim as new, and desire to secure by letters patent, is, the combination of the engine, constructed substantially as described, with a furnace in which it revolves, and which generates the steam with which it is driven, all as above set forth, by which what is denominated flash steam is employed in a rotary engine."

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49. For an *Improvement in the Steam Cross Cut Saw;* Lewis Kirk, Reading, Berks county, Pennsylvania, March 27.

The nature of this invention consists in attaching a cross cut saw to the cross head of a steam engine, hung on trunnions, in a frame, the ways on which the cross head slides being attached to the head of the cylinder, and the same passing through a guide at the end of the ways, so that by this arrangement the saw is operated directly by the piston rod, and is at liberty to move down through the log as it cuts, in consequence of having the engine hung on trunnions. My invention also consists in reversing the direction of the steam ways that connect the steam chest with the ends of the cylinder, in combination with the two tappets on the valve rod, which are struck by the cross head to shift the valve towards the end of each stroke, by means of which arrangement I am enabled to dispense with the rock shaft heretofore

employed in all engines which operate the valves by the direct reciprocating motion of the piston. And, finally, my invention consists in coupling the trunnions of the cylinder (which are hollow for the introduction and escape of the steam) with the steam and exhaust pipes, by having a cylindrical fillet on the end of each trunnion fitted to an annular cylindrical groove in the end of the steam and exhaust pipe, so that by putting packing in this groove, it can be forced up against the end of the fillet to make a steam-tight turning joint by means of coupling screws which pass through the flanch of the pipe, and a collar that turns on a groove cut in that part of the periphery of the trunnion which projects beyond the boxes in which it turns."

Claim.—"What I claim as my invention, and desire to secure by letters patent, is, first, combining with a steam engine, that is hung on trunnions to admit of its vibration as herein described, a cross cut saw attached to the cross head of the piston rod, as described, whereby the saw can receive its longitudinal motions to cut an up and down motion to pass through the log as it is cut, and to be lifted up preparatory to another cut, substantially as described."

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50. For an *Improvement in Reducing and Bleaching Straw and other Fibrous Substances;* Lemuel W. Wright (citizen of the United States, residing in London), March 27.

The patentee says:—"These improvements consist, firstly, in the novel arrangement and construction of the several parts of the machinery or apparatus employed, and in the application of the same to the process of reducing and bleaching straw and other fibrous substances (such as wheat, oat, rye, barley, or rice straw, wood, and jute weed, commonly called larat, as well as various kinds of grass and Indian corn, leaves and husks, &c.), to be used for the manufacture of various kinds of paper, mill board, card board, button board, &c.; secondly, in the particular machinery or apparatus for cleaning and washing all the dirty and extraneous matter from the straw or other fibrous substances. Thirdly, in the peculiar adaptation of the machinery or apparatus used or employed for reducing or grinding the same into a state of pulp by means of heavy rollers revolving on a plate. Fourthly, in the continuation of the washing of the fibrous substance in the pulpy state, and in the peculiar apparatus or machinery employed for the purpose of boiling the same by steam. And fifthly, in the machinery or apparatus for washing the pulp from the boiling process for performing the souring and chloride processes, and thus perfecting the operation of bleaching the pulp ready for use, as hereinafter described."

Claim.—What I claim as my invention, is the combination and arrangement of the respective parts of the apparatus, as described, by which the straw or other material is subjected in succession to the boiling, washing, and bleaching processes, the respective vessels, the tubes for the conveyance of water and steam and for the transference of the material, and the apparatus for reducing it to pulp, being arranged and operating substantially as herein set forth, by which

means the complete preparation of the paper pulp is effected more economically than heretofore. I likewise claim the construction of the apparatus for converting the pulp into paper, or mill board; said apparatus consisting of a water tight box, and of a deep frame the movable bottom of which constitutes the paper mould; said box, frame, and mould being in the arrangement of the parts and its operation, such as is herein described and represented."

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51. For an *Improvement in Ditching and Fencing*, Elhanan W. Thomas, Chicago, Illinois, March 27.

Claim.—"What I claim as my invention, and wish to secure by letters patent, is the combination of two ditching machines in the manner described, so that the sods cut from two parallel ditches shall be elevated and placed with the grass out in a continuous ridge between said ditches at one operation, in the manner and for the purpose set forth."

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52. For an *Improvement in Raising Water on Bars, Shoals, &c., for rendering them Navigable;* Waller Harris, Richmond county, Georgia, March 27.

"The nature of my invention," says the patentee, "consists in concentrating the water on the channel of streams when at or near low water mark, or below navigable point, by means of fixtures extending from one or both edges of the stream, according to circumstances, and rendering them navigable."

Claim.—"What I claim as my invention, and desire to secure by letters patent, is, the method of obtaining a line at right angles to the current of a stream, for the erection of eddies, piers, or other fixtures, employed in deepening streams, by means of the floating apparatus, provided with shafts and turning on the post, in the manner described."

MECHANICS, PHYSICS, AND CHEMISTRY.

Abstract of a Lecture on the Decomposition of Salts by Hot Steam. Delivered before the Pharmaceutical Society, London, February 9, 1848. By Professor E. Solly, F. R. S., F. G. S., &c.

That steam possesses considerable powers in effecting the decomposition of many substances has long been known; but the extent of these powers, the mode in which they act, and the effects to which they give rise in nature, are very little known: it was the object of this lecture to draw attention to this kind of decomposition, and to illustrate some very curious phenomena produced by it.

In introducing the subject, the Lecturer briefly adverted to the mode in which chemical affinity acts, and the two great changes, of combination and decomposition, to which it gives rise; the latter taking

place when some antagonist or interfering cause neutralizes or overcomes the force of chemical affinity; the most important of these causes were the following:—

1. *Superior affinity;* the commonest cause of decomposition, being either simple, when one substance separates two others, because it has a superior affinity for one of them, as where potassium decomposes water by abstracting its oxygen; or double, when two binary compounds mutually decompose each other, and form two entirely new substances.

2. *Spontaneous change*, or a tendency of compound substances to separate into their component parts; an effect in many cases produced by the mere re-arrangement of the elementary particles into simpler, and more stable compounds.

3. *Mechanical attraction.*—Chemical action, it is well known, is often checked and controlled by the mere force of aggregation; in some cases it appears to be even overcome by that power; thus strong solutions of the alkaline silicates are decomposed by sand, or finely divided silica, forming a hard and solid sandstone; in this case the silicate seems to be decomposed in consequence of the aggregative power of the silica.

4. *Heat*, which, like spontaneous change, in many cases produces decomposition by tending to resolve substances into mere simple compounds. In some cases, however, such as oxide of mercury, the decomposition is entire, the substance heated being wholly reduced into its elementary constituents.

5. *Light*, which, like heat, possesses the power of augmenting or diminishing chemical affinity, causing the combination of some substances, such as chlorine and hydrogen; and separating the elements of a number of compounds, such as those of silver, gold, mercury, &c.

6. *Electricity*, which, in passing through a number of compounds, causes their decomposition. All substances which are thus decomposed, appear to consist of simple equivalents of conducting and non-conducting matter: those which consist wholly of non-conducting elements, are entirely non-conductors, a property which likewise belongs to those compounds containing one equivalent of a conductor, united to two or more equivalents of a non-conductor; whilst those which consist of equal proportions of conducting and non-conducting matter are electrolytes or conductors, which undergo decomposition when liquid, but non-conductors when solid.

7. *Example.*—When two distinct compounds, having no action in each other, are mixed, if the one from any cause should undergo decomposition, it will, in many cases, tend to induce the decomposition of the substance with which it is mixed, even though the latter has independently no tendency to change or decompose. Fermentation is of this kind.

8. *Presence.*—Perhaps the most remarkable of all the sources of decomposition, is that kind of influence to which Berzelius, in 1835, gave the name of Catalytic action; a term which, without conveying any theoretical view as to the mode in which these effects are pro-

duced, must be taken as solely indicating those changes in chemical composition merely produced by the presence of certain substances, not undergoing any change themselves, or in any way chemically active in producing the effects observed. The decomposition of oxy-water by the metals, and of fused chlorate of potash by oxides of manganese and copper, are good illustrations of catalytic action. Those who advocate the contact theory of electricity, or believe that the mere contact of dissimilar kinds of matter gives rise to the evolution of electricity, may explain these phenomena on the supposition, that, as the electrical equilibrium of matter is disturbed by the contact of dissimilar matter, so the chemical powers of any substance will be more or less modified by the contact of other substances, even though they have no affinity or tendency to combine with the substance which thus influences them.

The decomposition of a substance is generally not caused by one of these forces alone, but by a combination of two or more of them together, the facility with which they act depending on the strength which binds together the elements of the compound. A very great difference is found to exist between even the same class of compounds: thus potassium and oxygen combine with the greatest facility and under any circumstances, however unfavorable; but are separated with very great difficulty, there being a wide range between the point of combination and that of decomposition. Oxygen and mercury, on the other hand, exhibit comparatively but little attraction for each other, and when combined, a very slight determining cause will produce their separation. In some cases, chemical affinity and the opposing forces are so nearly balanced, that combination or decomposition may be apparently produced at pleasure. The decomposition of steam by hot iron, oxide of iron, and hydrogen being produced, and the decomposition of hot oxide of iron and hydrogen, steam and iron resulting, is a familiar illustration of this balance of power.

In effects of this kind it is obvious some part of the action is produced by *mass*, as distinct even from that due to mere rapidity of action, or perfect mixture. When a solution of sulphuret of potassium or calcium is poured into excess of muriatic acid, a very different effect is produced to that caused by pouring muriatic acid into the sulphuret: in the former case bisulphuretted hydrogen is formed, in the latter sulphuretted hydrogen is evolved, and sulphur deposited.

Berthollet, on studying the nature of decomposition, was led to the conclusion, that when a compound was decomposed by the exertion of superior affinity, the result was not merely in accordance with the ratio of affinity, but depended also on several other conditions, and on the nature of the substances present. When, for example, a strong acid is added to a saline solution, he conceived that the base would not entirely separate from the weaker acid, and combine with the stronger one alone, but that it would be equally divided between the two, in the proportion of their relative mass. He conceived that single or double decomposition was never complete where no change of form took place—that two salts when mixed together would only half decompose each other, unless one of the resulting compounds was in-

soluble; when this was the case, or in any other way one of the products could be removed, as the remainder of the salts would then be half decomposed, and, as this action would continue with infinite rapidity, the whole of the compound would finally be decomposed.

Subsequent experiments showed, however, that this view was not correct, and that in many cases, Berthollet was misled by the formation of acid or basic salts. Some interesting experiments on this subject were made by Mr. Phillips in 1816 (*Quart. Jour.*, i, 80) showing the mutual action of carbonate of potash on sulphate of baryta, and carbonate of baryta on sulphate of potash. There are, however, many points connected with the decomposition of salts, requiring further investigation.

For more than fifty years it has been known, that under certain circumstances, steam possesses considerable power in aiding the decomposition of many compounds. This has, for the most part, been either attributed to superior affinity, or to mere mechanical action—it has not been recognised as a distinct and definite mode of decomposition, and, consequently, the recent experiments of Mr. R. A. Tilghman, whilst they unite a number of known phenomena under one general head, and exhibit a series of new and unexpected decompositions, show that the force which produces them is one of very high and peculiar power.

Mr. Tilghman has found that a large number of salts, including some of the most fixed and stable compounds known are readily decomposed by a current of steam, at a high temperature. It appears essential to this action, that the acid itself should be either volatile or decomposable at a high temperature, and the action is probably facilitated by any affinity which the base may have for water, the tendency to form a hydrate assisting in the expulsion of the acid. The temperature and other conditions requisite for this effect vary with different salts, depending on various circumstances, such as the affinity to be overcome, &c. In many cases also, decomposition is masked, or even wholly prevented, by interfering circumstances; yet these present no exception to the general rule, for it may readily be shown that decomposition takes place as soon as these interfering causes are removed.—*Amer. Phil. Trans.* x. 167.

The interesting experiments of Gay Lussac and Thenard, which arise out of their investigations into the nature of chlorine and muriatic acid, showed many remarkable instances of decomposition under the agency of steam. When, for example, dry chlorides were treated with dry boracic acid, they were not decomposed, though they were readily acted on when exposed to the influence of steam. This, it was at first supposed, depended on the fact that the acid could not exist in the dry state, but afterwards was shown to result from the want of oxygen to combine with the metal of the chloride, and form an oxide which could unite with the boracic acid.

These experiments, and the consideration they give rise to, were of considerable practical interest in connexion with lime burning, for it was shown that carbonate of lime is far more easily decomposed when heated in steam than in dry air, and on the other hand, that hydrate of lime is readily converted into carbonate when heated in carbonic

acid, bearing out the well-known fact that damp chalk or limestone is easier converted into quick lime than it is when quite dry. This action of water has been variously explained. Dumas regards it as either caused by the superior affinity of lime for water at a high temperature, which causes it to combine with the latter and set free the carbonic acid, or else that the steam being partially decomposed by the ignited fuel in the lime kiln, generates a portion of hydro-carbon, which decomposes the carbonic acid of the limestone, reducing it to the state of carbonic oxide (*Traité* ii, 247). Gay Lussac considers that the first explanation is inadmissable, because hydrate of lime is quite as easily decomposed by heat as carbonate, and shows the incorrectness of the second explanation by some excellent experiments, in which decomposition is shown to be wholly caused by the steam, quite independently of the products of combustion.—(*Ann. de Ch. et de Phys.* lxiii, 219).

Although it is perfectly true, that under similar circumstances, the carbonate and hydrate of lime are decomposed with equal facility by heat, yet it is also evident that the affinities are so nearly balanced, that some influence may be reasonably attributed to mass, and that the affinity of lime for water would be rather greater than for carbonic acid when the former was present in large excess. Another very important consideration is, the facility of diffusion. The mere mechanical effect of diffusion would facilitate the decomposition of carbonate in an atmosphere of steam, or hydrate in an atmosphere of carbonic acid. The conclusion drawn by Gay Lussac from his experiments, was, that the influence of steam in assisting the decomposition of the carbonates, was due to the increased facility given for the diffusion or escape of the carbonic acid.

The most important compounds which Mr. Tilghman has decomposed by the influence of hot steam are the earthy and alkaline chlorides, fluorides, sulphates, silicates, borates, phosphates, and chromates. Two interfering effects require to be guarded against in experiments of this sort, namely, the fusibility or volatility of the base when set free; those compounds which are fusible, or the base of which is fusible, are of course more difficult to decompose than others, as becoming superficially fused they are then for the most part protected from further action. On the other hand, when the base is as volatile as the acid, the two though separated by the steam, reunite to form the original compound nearly as rapidly as they are separated.

The decomposition of such substances by steam, is very greatly facilitated by the admixture of some infusible inert porous substance, which shall act as a retainer, mechanically preventing loss by evaporation or fusion.

Common salt, sulphate of soda, sulphate of baryta, &c., may be partially decomposed by steam alone, when sufficiently heated, but the interfering causes just mentioned, prevent more than a small portion from being decomposed; by the use of retaining substances, however, they may be rapidly decomposed to a very considerable amount, muriatic acid, or sulphuric acid mixed with sulphurous acid and oxygen, being given off, whilst caustic soda or baryta remains.

Several different theories, or modes of explaining this action, naturally suggest themselves; amongst these are, superior affinity, diffusion, and catalytic action. It is evident that in all feeble combinations, and especially those where both acid and base have a tendency to form hydrates, the affinity of the acid and base for each other may be weakened by heat, whilst that of both to form hydrates may not, or may be, proportionably less weakened. It is evident that in the case of all haloid salts, the presence of water must be essential to their decomposition by heat, whether alone or in the presence of another acid, as a source of oxygen to the metal, and hydrogen to the chlorine; and it is plain that, in most cases the separation of an oxide from muriatic acid, must be far more easy than that of a metal from chlorine. This action of water does not apply to the decomposition of other salts, unless we adopt the view of the composition of salts first advanced about 1815, by Davy, and afterwards brought forward by Dulong and others, according to which all salts are assumed to be formed on a similar type, the salts of the oxy acids being considered as consisting of the metals united to the acids + oxygen: thus chloride of sodium being Na, C, sulphate of soda would be Na. So_4. Perhaps the strongest argument in favor of this hypothesis is the manner in which it explains the relation of acid to the oxygen in salts of sesqui or deutoxides. There are, however, serious objections in the number of hypothetical substances the existence of which must be assumed, and in the fact that two distinct bases must be assumed to explain the composition of bi-salts.

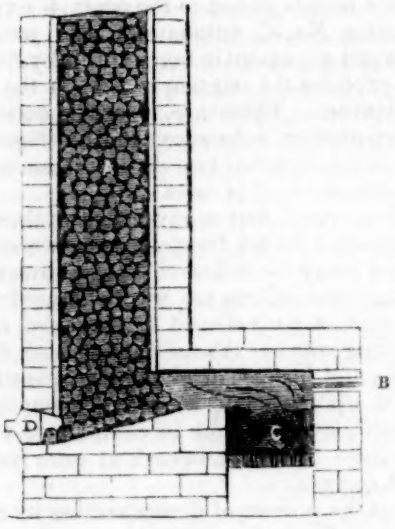
There can be little doubt that in several cases these decompositions are materially facilitated by the freedom with which the substances evolved are carried away by diffusion. It is, however, hardly possible to conceive that these effects are wholly caused in this manner; because, if they were, dry air should be expected to produce some effect in decomposing salts like the sulphates, which, however, appears not to be the case; and further, in some cases, the substance evolved has no tendency to diffuse, being at once decomposed, like chromic acid, which is readily evolved from its compounds with the alkalies, at a high temperature by steam, though at once resolved into oxide of chromium and oxygen.

In some respects the process of decomposition by steam approaches more nearly to the effects of catalytic action than to those of any other known mode of decomposition; at all events, though it may not be clear that they depend on the same power, yet it is evident that no other explanation can be considered as altogether comprehending the phenomena in question.

Independently of the scientific interest of these experiments, in connexion with the laws of affinity and decomposition, they possess great value in a practical point of view, both as indicating new processes of manufacture, and as explaining the nature of many geological phenomena which are of practical importance in the arts.

One of the most remarkable of the new manufacturing processes, and for which Mr. Tilghman has obtained a patent, is the direct decomposition of soda salts, and especially common salt. The experi-

ments of Gay Lussac and Thenard, as well as others, have long since shown that common salt may be decomposed by the action of various substances, particularly silex, when exposed to the influence of steam at a high temperature; but these cases appear to have been merely considered as decompositions by superior affinity or substitution, the result being only the conversion of common salt into some oxygen salt, in which the soda is strongly combined to an acid, from which it can only be obtained by a new process. In Mr. Tilghman's mode of working, common salt is mixed with some porous retaining substance, such as alumina, phosphate of lime, &c., decomposed by steam at a high heat, and the product simply lixiviated, when it *at once* yields a strongly alkaline lye. It must be borne in mind, that the retaining substances do not act merely by chemical affinity, but that their action is chiefly mechanical; this constitutes an important distinction between this and all other processes, and, as a necessary result, the soda obtained is nearly pure, and requires very little further manipulation.



The decomposition of salt in this mode, may easily be carried on continuously in a kiln, like lime-burning, balls of a mixture of salt and alumina being thrown in above, and withdrawn from the furnace below, when the operation is judged complete. The accompanying wood-cut represents the kind of kiln which has hitherto been employed, though there is little doubt that it will soon be modified and improved. C is the fire fed with coal or coke; A the kiln through which the whole products of combustion pass; the salt balls are thrown in above, and withdrawn from time to time at the discharge door D; B, the steam pipes through which a constant current of hot steam is allowed to pass over the ignited fuel, thus insuring a uniformly damp atmosphere in the body of the kiln.

The passage of the results of combustion through the kiln does not in any way interfere with or modify the decomposition of the salt; various practical precautions must be attended to, a certain temperature and a certain proportion of steam being found most advantageous. Under favorable circumstances, eighty per cent. of the salt employed has been decomposed and converted into caustic soda and muriatic acid.

When alumina is the retaining substance used, the solution of alkali obtained holds a large quantity of that earth in solution, in a very convenient form for the use of the dyer, being readily separated by mere exposure to the air, or even by the action of some coloring matters. When carbonate of soda is to be prepared, the solution may be readily carbonated by a current of carbonic acid which precipitates the alumina, or the furnace balls may be crushed and carbonated, *per se;* on lixiviation they then yield pure carbonate of soda, and the whole of the alumina remains insoluble ready to be employed over and over again in aiding the process of decomposition. For some purposes the presence of a small quantity of alumina in solution does not do any harm: thus, for example, the crude alkaline solution may be at once employed for the manufacture of soap.

Perfectly similar processes may be used to effect the decomposition of salts of baryta and strontia; but with these a somewhat higher heat than that required for the fixed alkaline salts is necessary, the fusibility of the results may be obviated by the use of porous retaining substances such as lime, and the operation may be conducted continuously in a kiln or reverberatory furnace.

In the decompositions of the sulphates a part of the acid passes off pure, the remainder being in turn decomposed by the heat into sulphurous acid and oxygen; it is probable that sulphuric acid might be economically made from a cheap sulphate, such as gypsum, by this process, as far less extensive or costly apparatus would be required than in the ordinary mode of manufacturing it from sulphur and pyrites.

The separation of other acids from bases, such as hydrofluoric, may also probably be practically employed with advantage. The decomposition of salts of the fixed acids, such as silica and boracic, though now more interesting as abstract facts, is probably less likely to lead to practical results. In these cases the volatilization of the fixed acids is assisted by the steam, in the same way that the distillation of oils, &c., is aided by steam: the fact that ignited silica is volatile in a current of steam has been known some time, from the interesting experiments of Jeffries, an account of which was read before the Royal Society in 1840, but not published in the Philosophical Transactions, *(Phil. Mag.* 1840, xvii. 299.*)*

It is evident from the foregoing fact, that in every case, when a hydrated salt is rapidly dried, it is liable to be more or less decomposed; this fact is worthy of attention, as the effect thus produced, in some cases, might introduce serious errors into processes of analysis. The tendency of chloride of calcium to undergo partial decomposition, when rapidly dried, has been known for some time. It is also worthy

of remark, that as all ordinary flames contain hydrogen, they are more or less moist, and consequently have a certain amount of decomposing power; hence the flame of a lamp, or candle even, is able alone to render many salts distinctly alkaline in a very short time.

In conclusion, Mr. Solly briefly adverted to the important light which these new experiments would probably throw on volcanic and other geological phenomena. Thus, for example, the evolution of boracic acid, in the hot springs of Tuscany, which has been accounted for on the supposition of a bed of sulphuret of boron, existing below the surface of the earth, and gradually undergoing decomposition from the action of water, could be far more simply explained, when it was shown that any salt of boracic acid, such as the borate of lime, is readily decomposed at a red heat by the mere presence of aqueous vapor.

Process for Bronzing different Metals. (*Note of* M. BECQUEREL.)

Translated for the Journal of the Franklin Institute.

MM. Brunel, Bisson, and Gaugain, have requested me to present to the Academy, pieces of different metals bronzed by an electro-chemical process, which has now been applied in the Arts.

M. de Ruolz had already communicated to the Academy in 1841, a process by which he bronzed several metals; that is, he deposited upon them, by the aid of the galvanic battery, layers more or less thin, of brass, or of bronze. This process, which required the use of the alkaline double cyanides of copper and zinc, or of copper and tin, was not adopted in practice, either on account of the high price of the cyanides, or from some other reason.

MM. Brunel, Bisson, and Gaugain, have substituted for the cyanides a solution in water of 500 parts of carbonate of potassa,

20 " chloride of copper,
40 " sulphate of zinc,
250 " nitrate of ammonia.

For bronze, a salt of tin is substituted for the sulphate of zinc.

By means of this solution, cast and wrought iron, steel, lead, zinc, tin, and the alloys of these metals either with each other, or with bismuth or antimony, may be easily covered with brass or bronze, after a previous cleaning depending upon the nature of the metal.

The operation is performed cold: the piece to be covered is put into connexion with the negative pole of a Bunsen (carbon) battery, taking for the positive decomposing pole, a plate of brass or of bronze.

When it is desired to cover large surfaces, experiment has shown that the number, and not the size of the couples must be increased.

When the pieces are coated, and have been colored as is usual in the arts, they rival the most beautiful bronzes. A very beautiful appearance may be given to coarse iron castings.

Pieces thus covered do not oxidize in the house. Those which are designed to be placed out of doors, must be varnished as usual. The

new process of which I have endeavored to give an idea to the Academy, will be valuable in the arts, and deserves to be encouraged.

Comptes Rendus de l'Academie des Sciences de Paris, March 20, 1848.

Commercial Value of Different Cochineals.

TRANSLATED FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

M. Cheveeul communicated to the Academy of Sciences of Paris, at their meeting on the 27th March, 1848, some very interesting experiments upon the comparative merits of a cochineal, raised in 1845, in Algiers, and the *Zaccatilla* cochineal of commerce, which is the black female insect of Mexico, which has died naturally after the deposit of her eggs. The following are his conclusions:

The cochineal of Algiers has less coloring power than the Zaccatilla, but the difference is less for scarlet than for crimson.

For crimson, the comparative values of the two are as 4 to 5. The cost of the Zaccatilla cochineal, being 19·5 francs per killogramme, tvalue of the Algerine will be, for crimson, 15·6 francs; but for scarlet, it will be worth 17·15 francs. At a mean about 16·35 francs.

He suggests an inquiry whether the difference of color, (the Algerine being more of an orange hue than the other,) may not be due to the different species of plant upon which the animals are fed; the Mexican insect being fed upon the *Cactus cochenilifer*, the Algerine upon the *Cactus Opuntia*. Ibid.

On the Polarization of Light.

TRANSLATED FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

The following are the conclusions from some experiments by M. J. Jamin, upon the polarization of light by reflexion from transparent substances:

1. That there exists no substance which polarizes light completely.
2. A beam polarized rectilinearly is always transformed by reflexion into one polarized elliptically.
3. The difference of phase varies from π to 2π, when the incidence increases from 0° to 90°.
4. The polarization is more complete, and Fresnel's laws more exact, in proportion as the index of refraction of the substance diminishes. Ibid.

Temperatures of the Arctic Ocean.

Translated for the Journal of the Franklin Institute.

The Proceedings of the Academy of Sciences of Paris, for March 13, 1848, contains the following account of a memoir, by M. Ch. Martins, on the temperatures of the Arctic Ocean, at the surface, at great depths, and in the vicinity of the Glaciers of Spitzbergen. The extract is by the author.

"This memoir rests upon 305 observations of temperature, made

by MM. Bravais, Pottier, and myself, in the four voyages of *La Recherche*, between Hammerfest, in Lapland, (latitude 70° 40′ North,) and Spitzbergen as far as 79° 34′ N., as well as in the neighborhood of the glaciers of that island, during the summers of 1838 and 1839. The principal results which follow from these observations, are the following:

I.—*Temperature of the Surface of the Sea.*

1. In the middle of summer, the temperature of the Arctic sea, is sensibly equal to that of the air.

2. Nevertheless, as a mean, that of the sea is a little higher, owing to the influence of the Gulf stream, whose extremities are lost upon the western shores of Spitzbergen.

3. The immense glaciers of Spitzbergen, which plunge and crumble into the sea, exercise a very sensible cooling influence upon its surface. The coasts of Norway, where glaciers do not descend to the level of the sea, tend rather to raise its temperature.

II.—*Thermometric Soundings at Great Depths.*

These temperatures are always the mean of the very concordant indications of several Walferdin thermometers, sent simultaneously to the bottom of the sea, and preserved from pressure by a sealed glass tube. The scales which were engraved upon the stems, were arbitrary, and nine divisions corresponded to one degree centigrade. The following are the most important conclusions from these experiments:

1. Between 70° 40′ and 79° 33′ North latitude, and from 7° to 21° 15′ longitude, East of Paris, the temperatures of the Arctic ocean decrease with the depths, during the months of July and August.

2. These temperatures are always above 0°, (32° Fah.,) at least to a depth of 870 metres, (953 yards,) the greatest depth attained in these experiments.

3. Comparing the temperature at the surface with that at the bottom and those intermediate, it appears that the decrease is uniform, at the mean rate of 0·625° per 100 metres, (0·343° Fah. per 100 feet, *nearly*.)

4. The temperature of a liquid layer is more constant in proportion as its depth is greater.

III.—*Temperature of the Sea in the Neighborhood of the Glaciers of Spitzbergen.*

1. In the months of July and August, the temperature of the surface, although very near the freezing point, is always above 0°, (32 F.)

2. From the surface to the depth of 70 metres, (230 feet,) the temperature sometimes increases, sometimes decreases.

3. From the depth of 70 metres, the temperature always decreases with the depth.

4. The decrease of temperature from the surface to the bottom is not uniform; but accelerates with the depth.

5. Between the surface and a depth of 70 metres, it is never below 0°, (32° Fah.)

6. Below the depth of 70 metres, the temperature of the water is below 0°.

7. As a mean, the temperature of this water is, 1·75°, (28·85° Fah.,) and consequently, above that of the maximum density and freezing point of sea water, as determined by M. Despretz.

8. These facts are easily explained, if we remember that the point of maximum density and that of freezing, of salt water, are several degrees below 0°, and if we take into consideration the complex influences, intermitting, and of variable intensity, exercised by the freezing of the surface during winter, the glaciers, the floating ice, the tides and currents."

Account of the Experiments to determine the Principal Laws and Numerical Data, which enter into the Calculation of Steam Engines, by M. V. REGNAULT.

(Continued from page 361.)

THIRD MEMOIR.

Determination of the Weight of the Litre of Air and of the Density of Mercury.*

In the preceding memoir, the densities of the different gases were determined, referring them to that of air assumed as the unit; but in a great number of circumstances, it is required to know the absolute weight of these gases: this is easily obtained when we know the absolute weight of air under the normal conditions, that is at a temperature of 0°, and under a pressure of 760 mil. of mercury.

The weight of the litre of dry air under the normal conditions was determined by MM. Biot and Arago, with all the care which they could take—they found that at Paris this weight was 1·299541 gr. (*Memoirs of the Academy of Sciences for* 1806. *Biot Traité de Physique, tom.* 1, *p.* 387.) This number has been generally adopted.

But if we reflect upon the imperfections which the theory of gases and vapors still presented at that time, and the great number of uncertain corrections which they were obliged to introduce into their calculations, and if we note that they operated upon air charged with aqueous vapor, for which they endeavored to allow by a correction; and that, in spite of the most minute precautions, this circumstance must necessarily introduce great disturbances into their experiments, we shall understand how absolutely necessary it was to make new determinations of this important doctrine, which will be frequently used in the following investigations.

In the preceding memoir, the weight of dry air which filled the globe at 0°, and under a pressure of 760 mil., was determined with great care; it will be enough then to find the capacity of this globe at 0°, to determine immediately the weight of the litre of air. Now,

* The French litre (the unit of measures of capacity) is 0·2639 of the U. S. standard gallon.

according to the principle upon which the French system of measures was established, the kilogramme is the weight of a litre of distilled water, freed from air, at the temperature of its maximum density which is about 4° (39·2° *Fah.*); it will suffice then to determine the weight of water at 4° which fills the capacity which the globe presents at 0°.

To do this M. Regnault operated in the following way.

The open globe was weighed upon a good balance; its weight was found to be 1258·55 gr. the surrounding temperature being 4·2°, and the height of the barometer reduced to 0°, 757·89 mil.

A small quantity of water was introduced into the globe, and the globe exhausted by means of the air-pump, and at the same time heated. In this way the atmospheric air was completely expelled by means of the vapor of water which was constantly developed. The stop-cock of the globe was then closed.

On the other hand, perfectly pure distilled water was boiled in a large globe to free it completely from the air which it always holds in solution at ordinary temperatures. Upon the tubulure of the first globe was fixed by caoutchouc a glass tube, twice bent, one of whose branches descended to the bottom of the vessel in which the water was kept boiling. On opening the stop-cock of the globe, the boiling water entered it slowly, without coming in contact with air; it was consequently perfectly free from that gas.

The globe being completely filled, the recurved tube was removed, and replaced by a tube having a bulb which was kept filled with the boiling water, and furnished the quantity of water necessary to keep the globe filled as its temperature lowered.

When the globe, filled with water, had come down to the surrounding temperature, it was placed in a zinc vessel, and completely surrounded with melting ice, care being taken to pack the ice in proportion as it melted, upon the walls of the globe.

The globe was left in the ice for a time varying from six to eighteen hours; the stop-cock was then closed, the bulbed tube detached, and the tubulure above the stop-cock carefully wiped.

The globe was placed in a large vessel filled with water at a temperature a little above that of the chamber in which the balance was; it was left for two hours, so that it should take nearly the temperature of the chamber. As the water contracts in proportion as its temperature rises from 0° (to 4°), the globe could be kept closed without danger of breaking. When the globe had acquired the temperature of the chamber, it was weighed, and this weighing (the temperature of the room and the height of the barometer being noted) gives the means of calculating the weight of water at 0°, which fills the capacity which the globe presents at 0°.

According to the experiments of M. Pierre (*Annales de Chimie et de Physique 3d serie, tome* XV, *p.* 348), if the density of water at 0° be taken as 1, at 4° it is $\frac{1}{0{\cdot}999881}$.

Whence we can calculate the weight of the water at 4° (its maximum

density), which fills the capacity which the globe presents at 0°. Three experiments give the following results:

I. 9881·060 grains.
II. 9881·113 "
III. 9881·299 "

The third weighing gave a number probably a little too high, because the globe was intentionally left but a little time in the ice, in order to see what influence this circumstance would have upon the result. On this account M. Regnault adopts the mean of the former experiments, viz: 9881·086.

Desiring to ascertain whether the correction made to reduce the weight of water from 0° to 4° was sufficiently exact, M. Regnault made two direct experiments, which gave a mean differing only 0·152 or $\frac{16}{100{,}000}$ from the result of the calculation. The capacity of the globe at 0° was therefore 9·881086 lit., and since (Second Memoir, p. 360) the weight of air which filled it at 0°, under a pressure of 760 mil., was 12·7781 gr.; the weight of the litre of air under these normal circumstances is $\frac{12{\cdot}7781}{9{\cdot}881086}$ gr. = 1·293187 gr., a value notably less than that which was heretofore admitted from the experiments of MM. Biot and Arago* (1·299541).

From this and the numbers obtained in the preceding memoir for the densities of the gases we deduce, that at Paris.

The litre of Atmospheric Air weighs			1·293187	grains.
"	"	Nitrogen	" 1·256167	"
"	"	Oxygen	" 1·429802	"
"	"	Hydrogen	" 0.089578	"
"	"	Carbonic Acid	" 1·977414	"

Strictly considered, these values are only correct for the locality in which the experiments were made, that is, for a latitude of 48° 50′ 14″, and a height of about 60 metres above the level of the sea.

M. Regnault finds the weight of the litre of air, under the parallel of latitude 45°, and at the same distance from the centre of the earth as that at which his experiments were tried, = 1·292697.

And, assuming this as the standard number, he deduces for any

*M. Renault remarks, in a note, that all the numerical corrections made by MM. Biot and Arago, for the purpose of reducing the weight of air to 0°, and to absolute dryness, contributed to render the number which they adopted too high. Another circumstance may have produced a similar effect. These experimenters exhausted the globe several times with a very good air-pump, and they supposed that the slight tension which remained in their globe was produced by the vapor of water which the walls of the globe abandoned in vacuo, which they recondensed when the air entered again. It is, in fact, probable that this was the case, but it seems to be also very probable that when the globe was filled with air very nearly saturated with moisture, it gave a new portion of water to the glass. This portion, which was not taken into account, was considered as making a part of the weight of the air, and necessarily made that weight too great. (*See Biot's Traité de Physique, tome* 1, *p.* 367.)

other latitude, and any other distance from the centre of the earth, the formula

$$w = 1\cdot^{gr}292697\ (1\cdot00001885)^{\frac{1}{1+\frac{2h}{R}}}\ (1-0\cdot002837,\ \cos:\ 2\lambda)$$

Or, more simply

$$w = 1\cdot^{gr}292673\ \sqrt{\frac{1}{1+\frac{2h}{R}}}\ (1-0\cdot002837,\ \cos:\ 2\lambda),\ \text{in which}$$

w is the weight of the litre of air, (the litre is 61·09908 cub. inches,
R the mean radius of the earth = 6,366,198 metres,
h the height of the place of observation above this mean radius, expressed in metres,
the latitude of the place.

Applying this formula to the level of the sea, in the latitude of Philadelphia (39° 56′ 51·5″), and assuming the radius of the earth at this point 6,367,653 metres:

The weight of the litre of air will be 1·2914392 gr.

And assuming the litre as 61·09908 cubic inches, and the gramme as 15·433159 grains troy:

The weight of a cubic inch of air will be 0·32621 grs. troy.

Or, (assuming Mr. Hassler's determination of the weight of a cubic inch of water, 252·6934 gr.) water is 774·63 times heavier than air.

Density of Mercury.

The density of mercury has been determined several times by M. Regnault, and with the greatest care, as he wished to satisfy himself whether this liquid, purified by the means employed ordinarily in the laboratories, presented a constant density.

A glass globe, of a capacity of from 250 to 300 cubic centimetres, was filled with mercury. The globe terminated in a capillary tube of about 2 mil. diameter, upon which a mark was made, and this tube was surrounded by a larger one which was used as a funnel. The funnel could be hermetically closed by a ground glass stopper. The globe being filled with mercury, this liquid was boiled, and suffered to cool. The globe was then placed in ice for several hours, and the level of the mercury brought exactly to the mark. As soon as it was satisfactorily ascertained that the level of the mercury did not change, the mercury was suffered to take the temperature of the air, and its weight determined. The same globe was then filled with distilled water first boiled to deprive it of air. It was suffered to cool, the funnel being kept full of boiled water, and closed with its stopper. The globe was then surrounded with ice, and when the water had taken exactly the temperature 0°, the water level was brought to the mark, and the sides of the funnel wiped with filtering paper. The closed globe was then placed in water having nearly the temperature of the surrounding air, so as to bring it more quickly to the temperature of the air in which it was to be weighed.

The three determinations of the density of mercury, which are reported, were made at very different times, upon specimens from different sources, and in three different globes.

I. The first specimen was mercury designed for the construction of a standard barometer for the observatory of Paris. This mercury came directly from the mine; it had been twice distilled in an iron vessel. It was then suffered to stand for several days under weak nitric acid, to dissolve the oxide of mercury which always forms during distillation. The metal was then washed with much water, and dried in the air-pump.

The density of the mercury at 0°, compared with that of water at 4°, was 13·59599.

II. In the second experiment, the mercury employed was that used by M. Regnault, in the construction of his manometer. This mercury was distilled several years ago, in an iron retort, and has been kept in glass vessels. It is frequently purified by shaking it in flasks with concentrated sulphuric acid, then washing with much water.

Its density at 0°, compared with that of water at 4°, was 13·59578.

III. Recently, M. Regnault has determined the density of mercury prepared with the greatest care by M. Millon, by the calcination of crystallized nitrate of mercury in a porcelain retort. The metal was then shaken up with concentrated sulphuric acid, to dissolve the oxide.

Density of the mercury, 13·59602.

Thus we find for the densities of these three specimens of mercury:—

I. 13·59599
II. 13·59578 } 13·59593.
III. 13·59602

These densities may be considered as identical.

MM. Biot and Arago found the density of mercury, 13·588595.

This density differs but little from those which we have found. The little difference ought probably to be attributed to the uncertainty of the corrections, which these illustrious physical philosophers were obliged to make in their method of operating.

It is often necessary, as in measuring heights by the barometer, to know the ratio of the density of mercury to that of air.

Now 1 lit. of air at 0°, under a pressure of 760 mil., weighs 1·293187 gr.
" water at its maximum density weighs 1000·000000 "
" mercury at 0° " 13595·93 "

The ratio of the densities of mercury and air at the temperature 0°, and under the pressure of 760 mil. observed at Paris, is then 10513·5. At the level of the sea, and in latitude 45°, it becomes 10517·3, and at the level of the sea, at Philadelphia, 10527.735.

(To be Continued.)

On Chromic Acid as a Bleaching Agent, and on a Cheap and Easy Means of Recovering it. By Charles Watt, Sen.

Chromic acid has of late years become a very important agent in the bleaching of various articles, and particularly tallow and oils, more

especially palm oil; the best method therefore of using and then recovering it, so that it may again be employed, and the expense of the bichromate of potassa, every time the chromic acid is required, be saved, cannot fail to prove of great advantage to all large consumers of this article.

About twelve years since, after numerous experiments and much application, I found that no agent was so effectual for bleaching foul, dark, and offensive tallows and deep-colored oils (namely, palm, linseed, and rape oils) as the chromic acid. My only consideration, therefore, was, in what manner to obtain it, in the cheapest form, sufficiently pure for the intended purposes; and the deep red salt, the bichromate of potassa, was that from the decomposition of which I obtained the acid, in the following manner:—

To bleach half a ton of dark tallow or high-colored oils, from five to ten pounds of the bichromate of potassa is required, and from it the chromic acid is liberated by decomposing the salt thus:—

The bichromate, well bruised, is put into an earthenware, wooden, or leaden vessel (not iron, as the acids act on it), and about four times as much hot water is then poured into it,—the salt is then to be well stirred; afterwards, about one pound and a half of sulphuric acid (for every pound of bichromate) is carefully introduced, and the stirring is continued until the whole of the salt is dissolved. This liquid is chromic acid, mixed with sulphate of potassa and an excess of free sulphuric acid, which is found greatly to assist in the bleaching.

The next part of the operation consists in introducing it into the tallow or oil, which, previously melted and well settled from all extraneous vegetable and animal matters, and at about 130° Fahr., is to be put into a vessel of wood, capable of holding half a ton, leaving sufficient room for stirring. So soon as the liquid mixture of chromic acid, as before described, is poured into the tallow or oil, it is to be kept well stirred, until the whole of the color is removed, and a light pea-green has taken its place. The bleaching operation is now complete, and about four pailsful of boiling water are to be poured in, and the stirring to be repeated for five minutes; the whole is then left to settle for about two hours, when it will be found quite white and fit for use.

It was formerly our custom to add about four or five pounds of muriatic acid to the compound, but Mr. C. Watt, Jr., at the large factory of Messrs. Hawes, found that it increased the trouble and expense, with no real benefit, and therefore he omitted it, and used only sulphuric acid to decompose the bichromate of potassa.

The expense of bleaching one ton of bad tallow, or any deep-colored oil, is about £1,—it therefore became necessary to devise means of saving the chromic acid; and some years since I converted the oxide contained in the green liquid, left after bleaching, into chromate of lead; but it was found that this article would become so extensive in quantity, that all who used much chromic acid would be driven into another branch of business, quite foreign to their usual occupation; and Mr. C. Watt, Jr., therefore devised the recovery of it into chromate

of lime, equally as effectual as applied to bleaching, and much less in expense. His process is as follows:—

The green liquid, left after all the bleached oil is taken off, is put into another tub, and more water is added; then lime, made into a thick cream-like consistence, is gradually poured in till nearly all the sulphuric acid is saturated; the liquid is then run off into another vessel from the sulphate of lime, and into this liquid is to be gradually and carefully introduced some more of the cream of lime, till all the green oxide (powder) is precipitated, and the liquor is clear and colorless; this liquor is to be drained off, and fresh water poured in, and, when settled, it is again to be poured off, and a fresh quantity put in, in order to wash the precipitate; this is at last to be dried, and then put on an iron slab, heated to redness, and kept frequently stirred. From a green it will be gradually changed into a yellow powder, which is the chromate of lime, and which, by being decomposed by sulphuric acid in such quantity as to leave an excess of free sulphuric acid, yields chromic acid, quite as well adapted for bleaching as that obtained from the bichromate of potassa. By this process, the chromic acid can be recovered again and again, *ad infinitum*, and thus the method of bleaching by this agent is at once the most perfect and economical of any yet brought into operation.* It is almost needless to remark that where, as in the great manufactories in Lancashire, much chromic acid is employed, this easy and cheap mode of recovering it will prove highly beneficial.

It may here be remarked, that several other methods of bleaching tallows and oils have since been tried,—one consists in employing what is termed permanganic acid; but this agent so readily parts with its oxygen, that it is unmanageable, and is quite as expensive and much more troublesome. Another method is by blowing air through the goods, heated to a certain point; this, also, is found not so effectual as the chromic process, for there is considerable waste, and when made into soap, the color is much inferior. Lond. Journ. Arts & Sci.

Method proposed for taking the Votes in the National Assembly at Paris.

We take from a recent number of a French newspaper (La Vraie Republique, 25th of April, 1848,) the following ingenious contrivance proposed for determining the votes in the National Assembly.

The attention of the public has frequently been solicited of late to different projects for a similar purpose. But we do not remember to have seen one upon this principle—and we are not sure that it is not among the most simple and feasible of them all.

Each deputy is to have a ball of equal size and weight; at each seat are to be placed two small tubes, and the occupant of the seat drops his ball into one or the other of these according as he wishes to vote, *aye* or *nay*. Under each of the corridors which separate the ranges of seats are placed two larger tubes, extending from the extremities of

* The patent for bleaching and purifying dark tallows and deep-colored oils was taken out about twelve years ago by the writer.

the hall, into one of which open all the tubes destined to carry the affirmative, and into the other those destined to carry the negative votes. These tubes are established with properly calculated slopes so as to bring the balls certainly and rapidly along them, and each terminates in a counterbalanced reservoir, the adjustment of which allows the appreciation of all weights from that of a single ball up to that of nine hundred (the number of votes in the Assembly). Each reservoir acts upon a separate index hand (that for the affirmative votes being white, that for the negative black), which move over a semicircular dial sufficiently large to be divided into the requisite number of parts easily visible from all parts of the hall. The position of the hand will then at once indicate the number of votes, *aye* and *nay*.

Mean Yearly Value of the Agricultural Products of France.

We extract the annexed interesting tabular statements from a communication made to the Academy of Sciences of Paris (27th of March, 1848,) by M. A. Moreau de Jonnès, who has been engaged for the last fifteen years in studying the subject of the wealth of France.

General Table of the Mean Yearly Value of the Agricultural Products of France. (1840.)

Gross annual revenue from cultures,	5,092,116,000 francs.		
" " " pastures,	646,794,905 "		
" " " forests, nurseries, &c.,	283,258,325 "		
Total revenue from vegetable products,		6,022,169,450 francs.	
Gross " " domestic animals,	767,251,000 "		
" " " animals slaughtered,	698,484,000 "		
" " " bees' wax and honey,	15,000,000 "		
Total " " animal products,		1,480,735,000 "	
Total agricultural products,		7,502,904,480 "	
	or $1,500,580,890.		

Table of the Comparative Agricultural Wealth of France, at Different Epochs, (omitting the Animal Products, of which no former returns can be obtained).

Date.	Reign.	Population.	Agricultural Revenue.	
			Gross.	For each inhabitant.
			francs.	*francs.*
1700	Louis XIV.	19,600,000	1,500,000,000	77
1760	Louis XV.	21,000,000	1,526,750,000	73
1788	Louis XVI.	24,000,000	2,031,333,000	85
1813	The Empire.	30,000,000	3,356,971,000	118
1840	Louis Philippe.	33,540,000	6,022,169,000	180

New Mode of Lighting by Electricity. By Mr. Staite.

Mr. Staite, having described his galvanic battery and other apparatus, which are on an entirely new principle of his own maturing, and which cannot be well described without diagrams, observed that the production of light from electricity was not a new thing *per se*. The experiment of the charcoal points, and the phenomena of the voltaic arc, with powerful batteries, were well known. The difficulties hitherto experienced had been—1. The economical production and application of the electric currents.—2. The discovery of a suitable material for the development of the light.—3. The rendering of the light permanent (the greatest difficulty of all). By what means, and to what extent, he had overcome these difficulties, Mr. Staite informed his audience. He produced, under a glass receiver, a brilliant light, before which the gas jets of the lecture-room turned, not pale, but yellow. "The peculiar characteristics of the electric light (said Mr. Staite) were its purity and volume. The most delicate shades of color might be detected, while the eye was not distressed by its effects. The same quantity of light, developed by gas, or any other known means, would be absolutely unendurable. That the light was not the result of combustion, strictly speaking, was evident. There could be no combustion without the presence of oxygen; and, as the light was developed to the best advantage under a closed glass, from which supplies of atmospheric air were excluded, it was quite certain that combustion had nothing to do with the matter." The light, in fact, the lecturer remarked, could be produced as readily in water as out of it. He showed its peculiar applicability to coal mining, for it could not explode the foulest atmosphere. He then came to the comparative cost of the electric and other lights. With a battery consisting of four small cells, a light was developed equal to 380 mould candles (sixes), or 300 wax candles, or 64 cubic feet of the best gas, burnt in the standard burner. This was effected by a consumption of zinc equal to 0·77, or 77-100ths of a pound, being little more than ¾ lb. of zinc per hour. When the light, however, was brought to its maximum, by increasing the distance of the electroids to their limit, the light was increased nearly threefold, whilst the current itself was reduced to about three-fifths in quantity. "This curious fact (continued Mr. Staite) I have frequently observed before. So that the light, when developed under the best circumstances consistent with its permanence, was produced by a consumption of a seventh part only of a pound of zinc per hour—and that light equal to 380 tallow candles. Assuming that the zinc so consumed was worth one halfpenny, and that the cost of the working solution, deducting the value of the products (sulphate of zinc, &c.), was as much more, we have the following comparative result:—Electric light, 1d. per hour; gas light, equal thereto, 6d. to 8d.; tallow candles, 7s. 6d.; wax, 12s. 6d." [But, in addition to the zinc and solution, an allowance must be made for apparatus, skill, labor, &c., as in the manufacture of other lights—gas, wax, tallow, &c.] In conclusion, Mr. S. observed, "By a careful comparison of all modes of effecting artificial illumination

I think I am justified in saying that there is no light so cheap as that evolved by voltaic currents of electricity; and there is certainly none which exhibits such pure and brilliant results. The absence of all smoke and flame, and noxious gases—the non-consumption of oxygen—the impossibility of its igniting surrounding substances—and the simplicity of the apparatus—are powerful recommendations for the adoption of the light in all places where purity, and brilliance, and safety, and economy, are sought for."

In the course of his address, Mr. Staite truly observed, in reference to the alleged jealousy of coal-owners, gas-makers, &c., that it was idle to throw obstacles in his way; if his electric light had superior merit on its side, it would come into use in spite of any local opposition; if, on the contrary, in practical value it was inferior to others, it would fall into oblivion. Civ. Eng. & Arch. Journ.

On the Use of Gutta Percha in Electrical Insulation. By MICHAEL FARADAY, F. R. S.

I have lately found gutta percha very useful in electrical experiments; and therefore, that others may take advantage of its properties if they have occasion or are so inclined, give you this notice for insertion in the Philosophical Magazine. Its use depends upon the high insulating power which it possesses under ordinary conditions, and the manner in which it keeps this power in states of the atmosphere which make the surface of glass a good conductor. All gutta percha is not however equally good as it comes from the manufacturer's hands; but it does not seem difficult to bring it into the best state: I will describe the qualities of a proper specimen, and refer to the differences afterwards. A good piece of gutta percha will insulate as well as an equal piece of shellac, whether it be in the form of sheet, or rod, or filament; but being tough and flexible when cold, as well as soft when hot, it will serve better than shellac in many cases where the brittleness of the latter is an inconvenience. Thus it makes very good handles for carriers of electricity in experiments on induction, not being liable to fracture: in the form of thin band or string it makes an excellent insulating suspendor: a piece of it in sheet makes a most convenient insulating basis for anything placed on it. It forms excellent insulating plugs for the stems of gold-leaf electrometers when they pass through sheltering tubes, and larger plugs supply good insulating feet for extemporary electrical arrangements: cylinders of it half an inch or more in diameter have great stiffness, and form excellent insulating pillars. In these and in many other ways its power as an insulator may be useful.

Because of its good insulation it is also an excellent substance for the excitement of negative electricity. It is hardly possible to take one of the soles sold by the shoemakers out of paper or into the hand, without exciting it to such a degree as to open the leaves of an electrometer one or more inches; or if it be unelectrified, the slightest passage over the hand or face, the clothes, or almost any other sub-

stance gives it an electric state. Some of the gutta percha is sold in very thin sheets, resembling in general appearance oiled silk; and if a strip of this be drawn through the fingers, it is so electric as to adhere to the hand or attract pieces of paper. The appearance is such as to suggest the making a thicker sheet of the substance into a plate electrical machine for the production of negative electricity.

Then as to inductive action through the substance, a sheet of it is soon converted into an excellent electrophorus; or it may be coated and used in place of a Leyden jar; or in any of the many other forms of apparatus dependent on inductive action.

I have said that all gutta percha is not in this good electrical condition. With respect to that which is not so (and which has constituted about one-half of that which, being obtained at the shops, has passed through my hands,) it has either discharged an electrometer as a piece of paper or wood would do, or it has made it collapse greatly by touching, yet has on its removal been followed by a full opening of the leaves again; the latter effect I have been able to trace and refer to a conducting portion within the mass covered by a thin external non-conducting coat. When a piece which insulates well is cut, the surface exposed has a resinous lustre and a compact character that is very distinctive; whilst that which conducts has not the same degree of lustre, appears less translucent, and has more the aspect of a turbid solution solidified. I believe both moist steam-heat, and water-baths are used in its preparation for commerce; and the difference of specimens depends probably upon the manner in which these are applied, and followed by the after process of rolling between hot cylinders. However, if a portion of that which conducts be warmed in a current of hot air, as over the glass of a low gas flame, and be stretched, doubled up, and kneaded for some time between the fingers, as if with the intention of dissipating the moisture within, it becomes as good an insulator as the best.

I have soaked a good piece in water for an hour; and on taking it out, wiping it, and exposing it to the air for a minute or two, found it insulate as well as ever. Another piece was soaked for four days and then wiped and tried: at first it was found lowered in insulating power; but after twelve hours' exposure to air under common circumstances it was as good as ever. I have not found that a week's exposure in a warm air cupboard of a piece that did not insulate made it much better: a film on the outside became non-conducting; but if two fresh surfaces were exposed by cutting, and these were brought into contact with the electrometer and the finger, the inside portion was still found to conduct.

If the gutta percha in either the good or the bad condition (as to electrical service) be submitted to a gradually increasing temperature, at about 350° or 380°, it gives off a considerable proportion of water; being then cooled, the substance which remains has the general properties of gutta percha, and insulates well. The original gum is probably complicated, being a mixture of several things; and whether the water has existed in the substance as a hydrate, or is the result of a deeper change of one part or another of the gum, I am not prepared

to say. All I desire in this note is to make known its use in the arrangement of extemporary or permanent electrical apparatus for the advantage of working philosophers, both juvenile and adult.

Royal Institution, Feb. 9, 1848. Lond. Phil. Mag.

Explosion on Board a Vessel laden with Steam-coal.

An inquest was held at the Town-hall, Cardiff, on Thursday last, before R. L. Reece, Esq., coroner, on view of the body of J. Grocey, chief mate of the barque *Neptune*, of Jersey, now lying in the Bute Dock. It appeared in evidence, that the vessel above-named was loaded with steam-coal, and was lying near Mr. Powell's wharf. On Wednesday night, the deceased having lighted a lucifer match, a terrific explosion took place in the hold, by the force of which the whole of the cabin and main hatchway were blown to atoms. The capstan was blown up to the height of the main rigging. The mate was killed on the spot—his remains presenting a most frightful spectacle. A boy named R. Smith, had his hands and face burnt but not severely; and another boy had his hair and eyebrows singed. The captain and his wife, who usually slept on board, were on shore that night. The damage sustained by the vessel is estimated at £400. Verdict—Accidental Death. [Accidents of this nature may be avoided by merely taking the precaution of keeping open the hatches for a few hours after the shipment of the cargo, that the gas, which is occasionally evolved from the Merthyr coal, may escape.] Lond. Min. Journ.

New Method of preparing Chloroform. By Prof. Böttcher.

Equal parts of chloride of lime and acetate of soda are distilled to dryness in an iron retort. But little chloroform is obtained in the first distillation, but a large quantity of dilute acetone, which is mixed with chloride of lime, and submitted to a second distillation. But the whole of the acetone is not decomposed in this operation, and it is consequently necessary to mix the product with more chloride of lime, and again distil. The product is rectified over caustic lime. This method is said to effect a great saving. Lond. Chem. Gaz.

BIBLIOGRAPHICAL NOTICES.

Elements of Natural Philosophy, being an Experimental Introduction to the study of the Physical Sciences, by Golding Bird, M. D., &c., &c., *with* 372 *Illustrations. From the Revised and Enlarged Third London Edition. Philadelphia: Lea & Blanchard,* 1848.

The work of Dr. Bird was intended, as he has stated in the preface to his first edition, as an introduction to the study of more elaborate works upon the subject. It would not therefore be fair to examine

it for the purpose of criticism, under any other view. The want of a work of this kind was very much felt by the English student; for while the higher works upon the subject were unnecessarily filled with mathematical demonstrations to such an extent, that the physical ideas were, in not a few instances, entirely lost sight of, the lighter works, which professed to avoid the use of the mathematical forms of reasoning, and to adapt themselves more exclusively to popular perusal, were very generally written by authors ignorant of the subjects of which they professed to teach, or else more bent upon illustrating their own eloquent style of writing, than the phenomena of Nature. They were therefore essentially either incorrect or imperfect, and generally both. The principal apparent exception to this assertion, is the admirable work of Dr. Young; but beside a certain obscurity of expression in the explanations of Dr. Young, which renders his work less advantageous than it at first appears, to one altogether ignorant of the subject, the book had become obsolete by the rapid advances of sciences since the author's time, and the new edition by Mr. Kelland, though an interesting and beautiful book, does not by any means correct this defect.

The want of a work of the kind which Dr. Bird proposed to furnish, was therefore much felt in the English language, and the method in which his work was executed, fully supplied the deficiency. The treatises upon the various subjects comprised under the general term Natural Science, are full and generally accurate, and they are so arranged as to connect them together in their proper order in the mind of the reader, and thus present the science as a whole, and not as a mere conglomerate of totally dissimilar parts.

The third edition introduces in their proper places the discoveries and improvements which have been made in the science, since the others were published, and presents to the student the most recent view of the subject.

We regard this book as a very valuable one, and can affirm that it fulfils the purpose for which it is intended; it is written by a gentleman fully versed in the matters of which he writes, and in a plain, and unornamented style, which renders it easily comprehensible.

The mechanical execution of the work by Messrs. Lea & Blanchard, is unexceptionable, but we cannot but regret that the system of beautiful illustrations which so profusely adorn the far inferior work by Müller was not applied to render still more popular the excellent treatise of Dr. Bird. F.

Chemical Technology, or Chemistry applied to the Arts and Manufactures; by Dr. F. Knapp, *Professor at the University of Gressen. Translated and edited, with numerous notes and additions, by* Dr. Edward Ronalds, and Dr. Thomas Richardson. *First American Edition, with notes and additions by Professor* Walter R. Johnson, *of Philadelphia. Vol.* 1, *illustrated with* 214 *engravings on wood. Philadelphia, Lea & Blanchard,* 1848; 8*vo. pp.* 504.

This is the third volume of the series of illustrated scientific works

re-published by Messrs. Lea & Blanchard, and we think it will prove the most popular, as it is decidedly the best of the series. Written by one who has for many years studied both theoretically and practically the processes which he describes, the descriptions are precise, and conveyed in a simple unpretending style, so that they are easily understood, while they are sufficiently full in detail, to include within them everything necessary to the entire comprehension of the operations. The arrangement in groups of those branches of industry, which are allied together by some general theory common to them all, is a very happy idea, and while it renders the study easier, it adds to it additional interest. The work is also carefully brought down to include the most recent improvements introduced upon the continent of Europe, and thus gives us full descriptions of processes to which reference is frequently made in other works, while many of them are, we believe, now for the first time, presented in a complete state to the English reader. The English editors have also performed their task with talent and faithfulness, as is evidenced by the large and judicious additions which they have made, describing British inventions and improvements, and giving us the latest results of British science and ingenuity. Professor Johnson, the American editor, has also added to the collection, several contributions of interest to the American reader, among which we would particularly notice the table of the results of the experiments of Mr. Bull, upon the different kinds of wood used as fuel; and a digest of his own elaborate investigations into the relative values of different American coals.

But we regret to find that in reference to one of the most interesting subjects treated of in this volume,—that of the Manufacture of Gas for purposes of Illumination,—Professor Johnson has suffered his private prejudices to betray him into a serious violation of his duties as an editor, and has added an appendix containing strictures upon the gas works of our city, as inaccurate in their statements as they are misplaced in a work of this character. They are misplaced because, for the most part altogether unconnected with a treatise upon technological chemistry. If it can be shown that the superintendent of the gas works at Philadelphia, wastes in the process of manufacturing the gas, either the coal or the fuel, or makes a gas of less purity or of smaller illuminating power than he should, from his materials, then such defects would perhaps be proper subjects for comment in a work of this kind. We say perhaps—for we believe after all that the same space would be much more usefully employed in describing processes by which other operators did better. Professor Johnson does indeed charge a wastefulness of fuel, (though we are satisfied that if he will inquire of Mr. Cresson, he will find himself in error in his conclusions,) and a brief temporary defect in the purity of the gas, (arising as he well knows, from the incapacity of the purifiers then in use, to hold the quantity of material necessary for the enormous increase in the demand for the gas; and ceasing as soon as new purifiers of a larger size could be made). So far then as these two charges are concerned, our remark as to the misplacement of his criticisms does not apply. But in reference to the others, to a student of technology, or even to the general reader, they are altogether superfluous. The

secondary products being once produced, the question of their disposition is one of pure economy—and as, with the exception of the coke, nothing can be done with them, except sell them, it is no longer a matter of science or of art. The proper body, therefore, before whom to arraign a careless or dishonest superintendent, is the Board of Trustees, or if they are involved in the accusation, or will not entertain the complaint, the public, or the City Councils. And in any case, the fair and proper vehicle for the discussion, are the newspapers, where both parties may be fully and fairly heard. The editor of a book has no right to saddle his author with such charges which are necessarily unjust, because no reply is possible. The misplacement of these criticisms is moreover aggravated by the fact, that in truth, these, or very similar statements, have just been the subject of a very warm newspaper discussion, the upshot of which has been, we believe, the entire vindication of the management of the gas works. That the statements are inaccurate, might easily be shown, if our Journal were the proper vehicle for entering upon the discussion, and will doubtless be made manifest if the question be again raised in the proper quarter. But a more painful feature of these criticisms are the strange and most unwarrantable insinuations, which are introduced against the motives of those who have these works under their control. Against whom these are especially directed, whether against the superintendent, or the trustees, individually or collectively, we do not choose to inquire, but they manifest a spirit which is altogether unbecoming in an editor, and unworthy of a man of science. They indicate a personal feeling, which cannot be mistaken, and which will not, we think, increase the confidence of the reader in the charges with which they are accompanied. We hope that Professor Johnson, when he revises calmly these pages of his work, will see the error into which he has been led, and with this hope we strongly commend the original work, the additions of the English editors, and those of Professor Johnson, where he has not permitted his personal feelings to draw him into ill-timed and ill-deserved criticisms, upon what he has evidently not taken the pains to understand.

The mechanical execution of the work is of the same high character which distinguished the others, and we again especially call attention to the wood-cuts, as fine specimens of the perfection which our workmen have attained in this kind of printing. F.

FRANKLIN INSTITUTE.

Proceedings of the Stated Meeting, held May 18th, 1848.

Dr. R. M. Patterson, President P. T., Presiding.

Present, 31 Members.

The following Donations were announced:—

From Petty Vaughan, Esq., London—

A Catalogue of Specimens of Recent British Manufactures and Decorative Art, exhibited at the house of the Society of Arts, in London, from March 8th to April 20th, 1848.

From Hon. Charles Brown, Member of Congress, Washington, D. C.—
Congressional Documents of the United States Senate.
A Report from the Secretary of State, with the Correspondence of Mr. Wise, late United States Minister to Brazil, in relation to the Slave Trade.
From Hon. James D. Westcott, Jr., Senator of the United States, Washington, D. C.—
Congressional Documents of the House of Representatives.
Report of the Committee on Naval Affairs, in relation to the Alabama, Florida, and Georgia Railroad.
From R. P. Anderson, Esq., Washington City, D. C.—
Congressional Documents of the *Senate*.
Report of the Secretary of the Navy—of the Plans and Construction of the Depot of Charts and Instruments, with a Description of the Instruments, &c.
Report of the Secretary of the Treasury—containing the Annual Report of the Commissioner of the General Land Office.
Congressional Documents of the *House of Representatives*.
Letter from the Secretary of War, transmitting Statements of Contracts under Authority of the War Department.
Report of the Secretary of the Navy, in relation to the floating Dry Docks at Pensacola, Philadelphia and Kittery.
From Solomon W. Roberts, Esq., Philadelphia.
The First Annual Report of the Inspectors of the Philadelphia County Prison, made to the Legislature, February, 1848.
From Messrs. M'Clees & Germon, Lithographers, Philadelphia, Pennsylvania—
Lithographic Likeness of Joseph R. Chandler, Esq.
From Joseph Harrison, Jr., Esq., Russia—
Lithographic Likeness of Nicholas I, Emperor of Russia.

The Reports from the Officers and Standing Committees were received.

Three new Members were elected, and four gentlemen were proposed for election at the next meeting.

Verbal Communication from Dr. Hare, on the Rationale of the Explosion causing the Great Fire of 1845, *at New York.* (*See Proceedings of the Franklin Institute, for* 20*th April last, page* 392.)

Dr. Hare communicated to the meeting some inferences and facts, tending to explain the contradictory impressions which have existed respecting the competency of fused nitre to explode with water, or with aqueous, hydrogenous, and carbonaceous combustibles. This subject was treated of in reference to a series of detonations terminating in an explosion of tremendous force, by which, in July, 1845, the intensely ignited contents of a store, in Broad street, New York, were thrown over an extensive district, involving the destruction of about 200 houses and property estimated at two millions of dollars. As far as the oaths of highly competent witnesses could avail, no gunpowder was present; so that the result could only be attributed to the reaction between an enormous quantity of nitre and combustible merchandise with which the store was promiscuously occupied. In all there were three hundred thousand pounds of nitre in parcels of 180 lbs. (each secured by two bags, an additional bag having been put over that originally employed).

About 180,000 lbs. was situated upon the second floor, 50,000 on the first floor, and 80,000 on the third floor.

Of the merchandise, the aggregate was more than double the weight of the nitre.

It was, however, the general opinion of those best acquainted with the subject, that when ignited with combustibles, nitre produces only that species of combustion which is called deflagration by chemists, without being capable of the more violent and instantaneous reaction designated by the word explosion. This impression was strengthened by the failure of every effort (made by several eminent chemists employed by the Corporation of New York) to explode nitre by ignition with combustibles.

Nevertheless, agreeably to Hays, of Massachusetts, an explosion was effected in his laboratory, by bringing water into contact with about 100 lbs. of incandescent nitre; also the accidental falling of a jet of melted nitre on some water, in the laboratory of the University of Pennsylvania, had been productive of a similar result.

The explosion of a vessel ladened with nitre, which, while lying in Boston harbor, was burnt to the water's edge, and of others similarly ladened and burnt, could only be explained by supposing that nitre, when sufficiently heated, will explode with water on due contact. Consistently, it might be inferred that this salt (well known to be a compound of nitric acid and oxide of potassium or potash) would explode with any substance capable of yielding either or both of the elements of water or hydrogen. The presence of the latter would be equivalent to water, since it would, with the oxygen of the acid, form water.

In a letter, addressed to the distinguished chemist above mentioned, in July, 1845, Dr. Hare had adverted to the explosion which succeeds the combustion of potassium upon water, as arising from the combination of one portion of the water with the resulting incandescent globule of oxide, while the heat of this globule uniting with another portion of the liquid, converts it into high steam. Moreover, it was suggested that in this instance, chemical affinity between the water and the oxide, in causing the water and heated globule to coalesce, is equivalent in efficacy to the momentum of the hammer when a bar of iron, at a welding heat, is forced into contact with some moisture situated upon an anvil.

Dr. Hare presumes that no explosion can take place unless the reagents for producing it are held or brought together, at the moment of reaction, by a certain force, either chemical or mechanical.

Some chemical compounds, such as are formed with fulminic acid, or with ammonia, by metallic oxides, also the chloride of nitrogen and perchloric ether, explode violently without confinement, so as to fracture a plate or saucer, upon which a small quantity may be detonated; but pulverulent mixtures, such as gunpowder, however powerfully explosive when employed in gunnery or rock-blasting, in open vessels flash without fracturing them, or producing any report. In an exhausted receiver, gunpowder is far less explosive than when

subjected to atmospheric pressure in an open vessel. Nevertheless, when gunpowder is restrained until the temperature requisite for the appropriate reaction of its ingredients is attained, it exerts a force far exceeding that of the chamber confining it. In this respect it differs from steam, of which, when the temperature of the fire applied is sufficiently high, the explosive force is directly as the pressure before bursting, and this, of course, is commensurate with the strength of the confining boiler.

The ingredients of gunpowder, sulphur, charcoal, and nitre, to produce the greatest effect, require extreme comminution and intimate intermixture by trituration, and to be so granulated, that the flame of the portion first ignited may convey inflammation to the rest through the interstices between the grains. Its superiority over any other mixture of nitre with combustible matter destitute of sulphur, is conceived to be due not only to the pre-eminent susceptibility of this substance, of vaporization and inflammation, but likewise to its well known ability to decompose metallic oxides by attracting both the metal and oxygen. Since an opinion was expressed in 1845, in the letter above mentioned to Hays, that the formation of sulphide of potassium is the first step in the process of the explosive reaction of gunpowder, Faraday has alleged the flame of this compound to be, in the case in point, an important instrument in the propagation of fire throughout the mass.

The hepatic odor of the fumes consequent to the firing of cannon, and likewise of the washings of a gun after the customary service, demonstrate the production of a sulphide. It has been found that a filtered solution of the residue displays, when tested by iron, the red hue which indicates the presence of a sulphocyanide.

Agreeably, however, to a qualitative examination, the solid residue of exploded gunpowder consists mainly of nearly equal parts of carbonate and sulphate of potash, while the gaseous residue is constituted nearly of equal volumes of carbonic acid and nitrogen. Of course the sulphate may arise from the oxidation of sulphide, formed at the outset. Notwithstanding that the ingredients of gunpowder are prepared as above stated, confinement is necessary to prevent the grains from being thrown apart and chilled, so as to prevent the propagation of the ignition, through the congeries forming a charge, by means of the flame of the first portions fired. This was fully demonstrated by the exposure of a pile of gunpowder comprising enough for the charge of a musket, within an exhausted receiver, to a wire intensely ignited by a galvanic discharge. The grains did not take fire instantly, probably because the vapor evolved prevented actual contact; and when ignition did ensue it extended only to the production of a feeble flash. On examination, it was found that a portion of the powder had escaped inflammation.

In the next place, a like weight of gunpowder was consolidated into a cylinder by intense pressure. Thus prepared and ignited, by contact with an incandescent wire in the exhausted receiver, more than half of the cylinder remained unconsumed.

A much larger cylinder of the same mixture, similarly consolidated,

placed at the bottom of an iron pot, four inches in diameter and twelve inches in depth, on being touched by the end of an iron rod reddened in the fire, burnt at first like a squib, but towards the last was dissipated with an activity in some degree explosive, probably in consequence of the pressure created by the reaction of the gaseous current generated by its own deflagration.

The want of confinement, which is thus capable of lessening the explosiveness of gunpowder, of which the constituents are intimately intermingled, is still more enfeebling, where analogous reagents are ignited together without admixture or comminution. Under these circumstances, the reagents are made to recede from each other by the generation of that vapor or gas, to the evolution of which, under confinement, the capability of exploding is due. Thus sundered, they are chilled by radiation, so that the temperature requisite to sustain and communicate ignition is not supported. Moreover, the rapidity of reaction being as the multiplication of the points of contact, and these being fewer as the substances are less divided and intermingled, the deflagration takes place in detail, instead of having that simultaneousness which is indispensable to render it explosive.

In addition to the ideas above mentioned as having been conveyed in Dr. Hare's letter to Hays, it was urged, also, that his inference as to the explosion of water with incandescent nitre being attributable to a reaction analogous to that represented as taking place when potassium is burnt with the oxide of potassium, was supported by the fact, that at a white heat, the base of nitre spontaneously abandons its acid, while from water it cannot be separated by any temperature. Consequently, the presentation of substances, consisting of carbon, hydrogen, and oxygen, by yielding water to the base, could not but be productive of a result analogous to that which results from the presentation of sulphur and carbon.

The only obstacle is as follows:—Substances containing hydrogen and oxygen, whether in the proportion for forming water, like sugar, starch, gum, and wood; or having an excess of hydrogen, like oils and resins; moreover, all the constituents of nitre, even the base, are susceptible of the aeriform state at the temperature producible by the reaction of nitre with them. But when kept together until that point is attained, the explosive power must be fully equivalent to that of gunpowder. The reagents are in a state analogous to that of two gases extremely condensed.

The explosibility of incandescent nitre with water was illustrated in the small way, by heating a portion in a platina capsule by the flame of a hydro-oxygen blowpipe, and sudden immersion in the liquid. So active was the explosion, that a portion of the resulting hydrate flew out upon the operator. Yet, when thrown in the same state upon molasses or sugar, no explosion ensued: nevertheless, when a capsule containing nitre heated to the point of volatilization, was struck with the face of a hammer, coated with suger melted upon it and made to adhere by moisture, a detonation took place; a still more powerful detonation was produced as follows:—

Upon an anvil, a disk of paper, of three inches in diameter, was laid, covered with pulverized sugar. Over the sugar was placed another similar disk covered with pulverized nitre. A bar of iron, rather wider than the disks at a welding heat, was then held over them, and subjected to a blow from a sledge. An explosion, with a report like that of a cannon, ensued.

Instructed by the facts and considerations above stated, it is inferred that the explosions which contributed to extend the conflagration in New York, as above mentioned, arose from the reaction of the nitre with the combustible merchandise with which it was surrounded. It is presumed that as soon as the fire reached any of the gunny bags, it must have run rapidly through the whole pile, by means of the interstices necessarily existing between them, the nitre with which they were embued causing them to deflagrate. Much of the salt being thus brought to the temperature of fusion, it must have run about the floor, reached the combustibles, and soon found its way to the next story through the scuttles which were open. All the floors must have been rapidly destroyed by the consequent deflagration, far exceeding in activity any ordinary combustion. Meanwhile, the nitre being all liquified and collected in the cellar in a state of incandescence, and the merchandise conglomerated by the fusion of sugar and shell lac, aided by the molasses, the weight, the liquidity, and temperature, must have produced all the conditions requisite to intense detonations. The floors having been consumed, the store must have been equivalent to an enormous crucible of twenty feet by ninety, at the bottom of which were nearly three hundred thousand pounds of nitre, superficially heated far above the temperature producible by any furnace so as to convert the reagents into nascent aeriform matter under a pressure of half a million of pounds. The intense reaction, however, would not permit of durable contact. At each impact, the whole mass must have been thrown up explosively, and hence the successive detonations. But the chemical reaction, the heat, and the height of the fall, growing with their growth, and strengthening with their strength, the last elevation was succeeded by the thundering report and stupendous explosion, of which it has been an object to afford a satisfactory explanation.*

COMMITTEE ON SCIENCE AND THE ARTS.

Report on the Explosion of a Steam Boiler.

The Committee on Science and the Arts, constituted by the Franklin Institute of the State of Pennsylvania for the promotion of the Mechanic Arts, by whom were appointed a sub-committee to examine into the cause of the explosion of a stationary engine in Dillwyn street, Philadelphia, on the 20th day of March, 1848,

Report—

That they examined the fragments of the boiler, and found that it had been cylindrical, 14 feet in length, and 18 inches in

* In a short time a more circumstantial account of Dr. Hare's experiments and inferences respecting the subjects of the above communication will be published.

diameter, made of iron $\frac{1}{8}$ inch thick, and apparently not of very good quality. The rupture had taken place nearly in the middle of its length, and presented the appearance of a clean cut around the boiler, just at the edge of one of the sheets of which it was composed, and exactly along the line which must have been followed by the caulking-tool. There was no tearing of the body of the sheet, and no irregularity in the line of fracture, except for about $\frac{1}{2}$ inch in length at the lowest part, where there were some slight irregularities, as though the iron had torn there, after the rest had given way. Upon a closer inspection the mark of the caulking tool was plainly visible, and it was seen to have cut into the iron, sometimes to a considerable depth. The committee have no doubt that this carelessness in caulking the boiler materially weakened it, and thus determined the line of the fracture. It is proper to remark that it was stated to the committee, that the cylinder was not constructed for a boiler, but had been used as a condenser, and was bought by its late proprietor at second hand, and by him applied as a boiler.

The boiler had been placed in the second story of a frame building on the east side of Dillwyn street, and in the rear of the lots attached to the houses on Third street, and was used by a Mr. Reeve, to drive a small engine for the purpose of cutting tobacco. The boiler lay east and west, slightly inclining downwards to the east, which was the fire end. The fire-way extended from the front, backwards, beneath the boiler, and was then returned by an outside flue, which lay above the ordinary water-level of the boiler. A blower was attached to the engine; it appeared to have been recently added, and gentlemen who were familiar with the premises, asserted that there was nothing of the kind when the boiler was first erected. The chimney stack being destroyed, the committee could not determine whether any defect had existed in the draft.

The westward or back part of the boiler had passed through the front of the house, and struck the dwelling on the opposite side of Dillwyn street, driving in the front wall. The fire end of the boiler passed across the whole lot between it and the houses in Third street, a distance of 112 feet, and struck the edge of a doorway, in an 18 inch wall, which it destroyed. Both these projections indicate a great force of steam; and upon examination the committee found a distinctly marked water-line, showing that the depth of water at the point of fracture was only about 3 inches. There were, however, no conclusive marks of high heat on the iron.

Although the thickness of the iron had been reduced by the cutting of the caulking-tool, and although the iron did not appear to be of very good quality, yet the committee believe that it was capable, with proper care, of bearing with safety, any pressure necessary for the light work which the engine had to do. Assuming the iron to have been but $\frac{1}{16}$th inch thick, and taking its tensile strength at 50,000 lbs per sq. inch, it would have been capable of resisting a strain in the direction in which fracture took place, of more than 45 atmospheres pressure.

It is a little singular that the boiler should have given way in the direction in which, by theory, it is considerably the strongest. For a tearing strain in the direction of the axis of the boiler, the resistance would have been equivalent to but 25 atmospheres, (347 lbs. per square inch,) if we take 50,000 lbs.

A very simple calculation will suffice to show that the pressure within the boiler at the moment of explosion was enormous. In fact, if we suppose the boiler lying quite horizontal, the projectile force was sufficient to carry the eastern fragment over 112 feet, while it fell 12 feet by the action of gravity, that is in 0·866 sec. The projectile force, therefore, gave to a mass of about 300 lbs, a velocity of 130 feet per second.

In the opinion of the committee, therefore, the explosion of this steam boiler was owing to an excessive pressure of steam, probably generated instantaneously by the admission of water to overheated metal, and the line of fracture was determined by the weakening of the iron at the junction of two of the plates, by the careless use of the caulking-tool.

By order of the Committee,

WILLIAM HAMILTON, *Actuary.*

Report on MM. DURAND & PECQUEUR'S *process for manufacturing various articles from Leather.*

The Committee on Science and the Arts, constituted by the Franklin Institute of the State of Pennsylvania for the promotion of the Mechanic Arts, to whom was referred for examination the process for manufacturing various articles from Leather, invented by MM. DURAND & PECQUEUR, Paris,

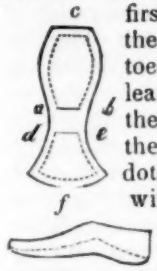
REPORT—

That they have examined with much satisfaction the various articles which have been brought before them by Mr. Rabeau, manufactured in leather by the process invented by MM. Durand & Pecqueur of Paris, of which process Mr. Rabeau is the patentee in the United States. They have likewise inspected the machine by which the various manufactures are produced. The patent is claimed for a method of manufacturing various hollow articles of leather without seams, such as fire-hose, sword, and bayonet scabbards, canteens, shot pouches, cartridge boxes, military caps, boots and shoes, cigar, and spectacle cases, &c., &c. The principle of the method is to divide the leather in a moistened state, in the direction of the plane of its length and breadth, making in the case of fire-hose, a slit through its entire length, leaving a border on both edges of the strip uncut. This is performed by means of a short knife at the end of a steel rod to which an alternate lateral motion is communicated by a peculiar mechanism; and this operation is performed with so much accuracy, that the slit is made directly through the centre of the strip of leather, leaving the two sides everywhere of the same thickness, supposing the original strip to be of a uniform thickness. In the case of sword

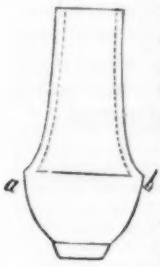
and bayonet scabbards, a mandrel is introduced, by which the piece can be made to assume the proper form and stiffness when dried.

In the manufacture of canteens, a piece of leather is taken of the requisite shape, which is a little broader than the vertical section of the canteen through its length and greatest breadth, in which a slit is cut so as to leave the uncut border everywhere of the same breadth. The leather is in the wet state when cut, and is filled with sand and a plug driven into the mouth, then dried, after which it retains the shape thus given to it, and may then be finished according to any of the ordinary methods. Melted wax, or a preparation of wax, is poured in the inside, which fills the pores of the leather, and prevents the infiltration of the liquids which it is intended to contain, and further from acquiring any unpleasant taste from it. Mr. Rabeau proposes to finish his canteens by subjecting them when filled with sand to pressure in proper moulds, by means of an hydrostatic press. His helmets and military caps are fitted on blocks, from which they take the proper shape.

Mr. Rabeau manufactures by this process a shoe, of a single piece of leather, excepting the heel-tap, even to the ties. A piece of sole-leather is taken of the form represented in the figure. The knife is first introduced along the line *a b*, slitting the leather in the shape of the dotted line to the end *c*, thus forming the toe. It is again introduced along the line *d e*, slitting the leather according to the shape given by the dotted line to the end *f*, forming the heel. When a last is introduced, the uncut border assumes the position represented by the dotted line in the figure. This border is then pared down with the knife so evenly, that in the finished shoe, the edge cannot be distinguished from the sides of the leather. A very neat article of the species of overshoes, called *clogs*, is fabricated by this method. There is not a seam in the shoe being all of one piece, except the heel.



The legs and uppers of boots are made likewise without seams. The original piece of leather is of the form given in the figure on the margin. The knife is entered at the line *a b*, and the heel and leg are formed by a slit of the shape given by the dotted line. The method generally adopted, however, is to have two short seams on each side of the boot-leg, near the sole. The boot is then finished in the ordinary manner. A very neatly finished boot was shown to the committee, the upper leather of which was finished in this manner. Also a shoe, the leather of which however, was not curried or dressed. Mr. Rabeau proposes to furnish a common kind of boot only by this method. The shape is given to the boots and shoes by the trees and lasts, while the leather is wet, and Mr. Rabeau thinks that when the leather is dressed and oiled, after the shape is given to the boot or shoe, it will always be retained in all circumstances of moisture and wear.



It is the opinion of the committee, that the process of MM. Durand & Pecqueur, is a great improvement over the old method of the manufacture of scabbards, canteens, and articles of a like description, avoiding as it does, all seams, and thus freeing it from the greatest liability of damage, and wear and tear, in use. The inner surface is perfectly clean and smooth.

Their method of manufacturing fire hose is one saving the labor of rivetting to a great extent; rivets being used only to join the strips after they have been slit. Whether, however, the leather in this state of diminished thickness, will be found sufficiently strong to meet the exigencies of the fire service in our cities, or in other large cities, the committee are not prepared to say. Experience can only pronounce with certainty. It is observed that the common hose wear most at the lines of rivets running across the general length of the hose. This of course will take place in the hose made according to the new process. Mr. Rabeau thinks his hose has an advantage over the common in reeling off and on the carriages, from the fact of its being nearly, if not perfectly flat, when not filled with water. A section of hose manufactured by Mr. Rabeau, was subjected to a pressure of 120 lbs. on the square inch, which it withstood successfully.

Another important application of this invention, is the covering of the draw-rollers of cotton spinning machines. There are objections to the old methods of wrapping the leather around the cylinder, and then sewing or glueing it as tightly as possible. It is found that the leather gradually stretches and works loose, and then is obliged to be removed or tightened. And further, it is found that it is difficult to get a perfectly round cylinder, on account of the seam. And as uniformity in the size of the thread depends upon this latter circumstance, any method which may overcome the difficulty is important. By the new process a slit is cut in a piece of leather of the proper size, and driven on to a metallic cylinder, which it is made to fit very tightly, and then placed in a lathe and turned perfectly smooth and round. It may be objected that the leather thus embracing the metallic cylinder so tightly, may lack the requisite degree of elasticity to accommodate any irregularity in its surface to the size of the thread. But it may be answered, that from the perfectly cylindrical shape which may be given to the roller, the leather does not require the same degree of elasticity. It seems to be an important improvement, and worthy the attention of those engaged in that branch of manufactures.

By order of the Committee,

WILLIAM HAMILTON, *Actuary.*

Philadelphia, May 11, 1848.

GLOSSARY OF MINING TERMS.

(From the London Mining Journal.)

(Continued from page 320.)

SOUTH STAFFORDSHIRE.

Air-head—A channel 2 feet 3 inches by 3 feet 6 inches, driven on a level with the top of the gate-road, and about 4 yards on one side of such gate-road.

Bildas, or *Buildhouse*—The men going down at 6 and working till 9, and sometimes 10 o'clock, is termed a bildas, for which the men get nothing but a drop of beer. This was originally denominated *buildhouse*, from the fact of the butty being able to *build* so many *houses* from the exactions thus made upon the men.

Blowing-tools—A small set of blasting implements.

Breakes—Are fissures, or cracks, that are found in working near old works, arising from the consolidation of such old workings.

Back-horse—The horse that draws the loading skip from the loaders to the wagon hole.

Bolt-hole—A passage same size as gate-road, but leading from the gate-road into a side of work, in which the dams are generally placed.

Bandsman—A man who loads up the coal.

Banksman—A man who lands the skip at surface.

Bow—A piece of wrought-iron passing from one side to the other of a skip, by which it is let down into the mine.

Bating—Lowering the gate-road, or other passage.

Benching-up—Holing above the measure, and then breaking up the lower part.

Bowke—A small wooden box, used for drawing clay and ironstone, and for sinking.

Butty—A getter of coals, or ironstone, by contract by the ton.

Curb—A circular piece of wood, pinned together as a foundation for the bricking of a shaft.

Crop—The line of inclination of a mine.

Calcining—Roasting iron ore.

Charter Master—See *Butty*.

Cutting—The coal being cut perpendicularly round the pillars and ribs, in order to let the coals fall.

Cog—A small square building of rough stones, or coals, left to support the roof during the operation of holing.

Cropping-out—When the seam crops out at surface.

Doggy—An underground superintendent, employed by the butty.

Downfall—A downthrow.

Dialling—Surveying the different ramifications of the mines by means of the magnetic needle.

Dresser—A large pick, used for preparing the large coals for loading into the skips.

Driving—Cutting and blasting horizontally, to make a level, or air-way, &c.

Dip—The line of depression of a mine.

Dan—A small wagon, used in ironstone mines.

Damp—Carbonic acid gas.

Dog-hook—A long hook, by which the empty skip is drawn in any direction.

Damp Sheet—A large coarse sheet, placed across the gate-road, to force air in another direction.

Doors—Stoppings for air in main gate-road.

Draught—The quantity of coals raised to bank in a given time.

Drink-time—Meal-time.

Drum—That part of the winding machinery on which the rope or chain is coiled.

Drop—Applies to a quantity of coal caused to drop by cutting—sometimes the thickness of 3 feet, and at others of 6 feet.

Druggon—A square wrought-iron or wooden box, used for lowering clear water into the mine for the horses, and for conveying water into the interior, &c.

Dams—Stoppings of fine sand and brickwork, of various thicknesses, in the gate-roads, to exclude the atmospheric air from old workings, to prevent spontaneous combustion.

Engine-pit—The pumping-shaft.

Elve—The handle of a pick.

Fault—A dislocation, with rock, or other foreign matter, lying between.

Fire-stink—Arises from the decomposition of iron pyrites, which is so abundant; hence the necessity of ribs, dams, &c.

Fast-end—The part of a face that juts against the solid.
Foot-hook—The large hook that is hooked to the bow of a skip, or tacklers, in drawing coals up the shaft.
Foot-hook chain—A strong chain at the end of the rope, and connected with the foot-hook.
Face—In ironstone mines, the work in progress.
Fleaing—Is practised when a gate-road, or other work, is about to be abandoned, as a system of robbing, as it is termed in the north, or an endeavour to thin the ribs to the greatest extent.
Fighting—Applies to the ventilation when reversed—as the upcast becoming the downcast, and *vice versa*.
Ground Bailiff—A superintendent, visiting the mines about once a week; has the entire directions, and should be made answerable for all accidents from breakages, bad ventilation, &c.
Gin—A wooded drum, with vertical shaft, cross-piece, beam, &c., by means of which shallow mines are realised.
Gate-road—A passage driven on the floor of the coals about 10 feet wide and 10 feet high, used to carry the coals along.
Gob—The refuse that is left behind when the work is completed, as small coal, earthy matter, inferior ironstone, &c.
Gob-road—A road that passes through that part of the mine which has been previously worked.
Garland—A trough, or gutter, round the inside of the shaft, to catch the water running down the sides.
Holing—The lower part of the coal being taken away, 2 feet 3 inches in height, in order to bring down the overlaying mass.
Hanger-on—The man who hangs the skip on at the bottom of the shaft.
Horse-fettler—The man whose whole duty it is to provide for, and attend to, the horses underground.
Hanging—Applies to that part of the seam which remains—as when the bottom coal is taken away, the top coal is hanging.
Horns—Guides for the rope on the drum.
Hand-gears—Small winding hand-barrel, used for preliminary sinking, or to realise very shallow mines.
Holing-shovel—A short-handled, round-bladed shovel.
Hovel—An erection at surface, near the pit's mouth, for the convenience of the banksman.
Jackey-pit—A small shaft sunk inside the mine, for various purposes.
Jig-chain—A chain hooked to the back of a skip, and running round a post, to prevent its too rapid descent on an inclined plane.
Knocking-up—The banksman beating (rather peculiarly) the runner at surface, to inform the miners below that it is time to come up.
Knob—A small support for the roof.
Lazyback—The place at surface where the coals are loaded and stacked for sale.
Lid—A piece of wood placed between the top of a prop of timber, and the roof of the mine.
Level—A water passage underground.
Log, or *Baby*—A balance weight, placed near the end of the pit-rope, to prevent its running back over the pulley.
Landing—The banksman receiving the loaded skip at surface.
Ladder—Strong wood ladders, 10 to 20 feet long, to enable the collier to affix his scaffolding, when cutting the top coals in.
Lever—Strong oak levers, 15 feet long, used to lift loaded skips on the rails, in case of their getting off, or accident, &c.
Lamp—The safety-lamps of Davy, Clanney, Stephenson, Upton, and Roberts.—The majority are made by local ironmongers.
Launder—A large wrought-iron or wooden spout, into which the water-barrel is lowered, and which conveys the water to a culvert, or other outlet, near the pit's mouth.
Mobby—A leathern girdle, with small chain and hook, used by lads in drawing the ironstone from low places, on small bowkes.
Mine Surveyor—A person who dials the workings of a colliery as often as requisite, and makes plans of the mines got and ungot.
Machine—The weighing apparatus used to weigh the coals at surface.
Man-o'-War—A small pillar left in some critical situation in a side of work.
Navvy—That part of the face of an ironstone mine laying between two roads.
Net—A strong cord net, by which the large and powerful horses are let into the collieries.

Openings—Those parts of the side of the work that are between the pillars and between the pillars and ribs.
Open Work—A coal quarry.
Pricker and *Puller*—A long sharp-pointed instrument, (not unlike a boatman's shaft,) used to break out the spurns left in cutting the coals.
Pillar—A square piece of coal, 9 yards square, left to support the roof, but which in completing the side of work is often robbed—viz.: parts cut away.
Parting—A small joint in the coal measure; and when one road leads out of another, that is a parting also.
Pikeman—A man who holes or cuts the coal.
Pit-frame—The framework carrying the pit pulley.
Pit-eye-pillar—A solid piece of coal, left round the bottom of shafts, for their protection.
Ring—A circular piece of wrought iron, about 8 inches deep, used to place on the skip of coals, to increase the load.
Rise—An upthrow.
Royalty—The dues payable to the real owner of the colliery.
Rib—A barrier of coal, left between each successive side of work, to prevent either water or obnoxious vapors, arising from such old workings, spreading over the whole pit.
Runner—Landing wagon for the skip at surface.
Roofing—When the top of the loaded skip wedges against the top of the gate-road.
Rake—A strong iron rake, for loading up into iron baskets the small coals.
Runner—Applies when any part of the winding machinery breaks, and allows the loading skip, or miners, to descend the shaft with the greatest velocity.
Rate—The sides of the gate-road, or other works, falling off, and obstructing the passage.
Rodney—A roughly constructed platform, with old rails, near the pit's mouth, upon which a large fire is made during the winter nights, to light the bank.
Stint—A given quantity of work to be performed.
Side-bassett—A transverse direction, or at right angles with the line of dip.
Sleepers—Are of wood or cast and wrought-iron, according to their different purposes.
Setting—Timber setting, or props, in various lengths.
Sump—Water room at the bottom of a shaft.
Sump-planks—Strong balks of timber, bolted together, forming a temporary bottom, or scaffolding, for the shaft.
Side-laning—Making the gate-road (when abandoned for that purpose) into an opening 10 yards wide—viz.: making the gate-road part of the new side of work.
Snatch—A small chimney at surface, about 6 or 8 feet high, connected with an air-furnace and trumpetting, used to ventilate very limited underground workings, by the means of one shaft, but much disused now.
Stall—An opening made between pillars in the direction that the work is progressing and the transverse openings—also termed *openings*.
Straight stall—An excavation made into the thick coal, having the solid coal left on three sides of it.
Scaffold—Planking elevated by stays and ladders, in order to allow the miner to ascend and disengage the coal in the upper part of the seam.
Shaft—A pit from 5 to 8 feet diameter, the smaller used for ironstone and the larger for coal mines.
Shift—The extent of time taken for any particular operation.
Slipes—The sledges at the bottom of the skip, used to draw the coals upon from the work in progress to the railroad.
Smut, or *Mucks*—Bad soft coal, containing much earthy matter, found in the immediate locality of faults.
Stays—Pieces of wood used to secure the pump-trees in the engine-pit.
Stamp—A mark cut in the roof or sides of the mine, as a point of reference, to show the amount of work done.
Spurns—Small ties, or connexions, left between the coals hanging and the ribs and pillars, to ensure safety to the miner during the operation of cutting.
Sulphur—Carburetted hydrogen gas.
Stage—A particular distance that a horse travels along the gate road, and where candles are regularly placed.
Shot—Blasting.
Skip—A sledge-shaped wagon, with a wrought-iron bow, used to draw the coals up the shaft.
Straw—A fine straw filled with powder, used as a fuse.
Stone—Ironstone.

Side of Work—An excavation in the 10 yard coal, varying in extent, composed of a series of 10 yard square openings, and 9 yard square pillars, according to the nature of the overlying strata.
Spout—A channel same size as air-head, and about 4 yards long, driven from the air-head into the gate-road at about every 15 yards, so as always to keep the communication as forward as possible.
Sumping—A small square shaft, generally made in the air-headings, when crossing faults, &c., or made to prove the thickness of coal, &c.
Shet—The roof of the coal mine when broken down.
Trade—Demand for coal.
Trumpetting—A small channel cut behind the brick-work of the shaft.
Throwing—Is generally done in the night, by breaking out the small spurs left at certain distances during the cutting, and so entirely disengage the hanging coal from the ribs and pillars—having nothing left then but its own cohesion.
Tipe—To upset, to overthrow a skip.
Turn-out—A short loop line of railway, made in order to allow one skip to pass the other in the gate-road.
Tie—A support for the roof attached to the rib, forming the shape of the letter T.
Trow—A wooden spout, made in various lengths, and from 4 inches to 2 feet square, used for carrying air, &c.
Tacklers—Four pieces of chain, terminating at one end with a hook, and the other in a ring, used to tackle up the skip with, when drawing it up to the shaft.
Thurl—To make a breach into former workings or gate-roads.
Tubbing—Cast-iron cylinders, in pieces, bolted together and placed in the shaft, to enable the sinkers to penetrate quicksand, water, &c., in safety.
Ventilating-flue—Trumpetting, commonly called, but to which a new name has been recently given.
Ventilating-stack—A stack 90 feet high, with partition, and large air-furnaces, and connected with the ventilating-flue—not much used at present.
Wagon hole—That part of the railroad ending in the side of work.
Whimsey—An engine used to draw up coals, applied more to the old atmospheric engines.
Way-end—Applied in ironstone mines to that part of the face where the road enters.
Wind-way—An air-way leading from one road to another.
Water-barrel—A large wrought-iron barrel, with a self-acting valve in the bottom, used in drawing water, where there are no pumps.
Wagon—A square platform, with four wheels placed under, for the purpose of conveying the skip of coals from the workmen to the bottom of the shaft.

CORRECTIONS TO CORNWALL MINING TERMS, page 293.

Blende—Is called *willd* (wild) lead, not *mock* lead.
Brace—Means the platform placed *over* the mouth of a shaft, or winze, and to which the tackle is fixed.
Core (pronounced *coor*)—A miner's *core* is generally *eight* hours, not *six*.
Cover—Is pronounced *coevur*.
Dredging ore—Should read *dradgy ore*, or *drady trade*—viz.: coarse poor stuff, containing but little ore.
Gossan—Is generally pronounced *gozzan*.
Lode Slovvan (a term omitted)—Means a *drang* (viz.: a drain, or open cutting) driven towards rising ground, on the indications of a lode in marshy ground.
Pot-grown—Read, *pot-growan*.
Quere—Read *queere*, or *qweear*.
Sett—The boundaries and terms of the mining ground taken by the adventurers.
Sumpmen—Not only assist the pitman, but sink the engine-shaft also.
Turning-house—The first working on the lode after it is cut in a cross-cut.
Vugh—Should be spelt *vugg*, and almost pronounced *voog*.

INDEX.

List of American Patents, with Remarks, &c.

			Page.
	May, 1842.		
40.	Solar Lamps	B. H. Horn	43
41.	Hot-air and cooking Furnace	Otis Packard	ib.
42.	Boats' oars, sawing from planks, &c.	J. Benson & E. Page	ib.
43	Lamps for lard	Archibald H. Baird	44
44.	Bee hives	Elijah Grumman	ib.
45.	Gloves, hose, &c., from wool, &c.	Marmaduke Osborne	ib.
46.	Corn cultivator	A. Wood, D. Wells, & I. Bates	45
47.	Ruling letter paper	George L. Wright	ib.
48.	Grain cleaner	D. Flickinger & S. Krim	ib.
49.	Cultivators	John Mason	ib.
50.	Brushes for dressing warp	Samuel Taylor	46
51.	Stave dressing	Samuel Leamed	ib.
52	Loom for weaving counterpanes, &c.	Erastus B. Bigelow	ib.
53.	Substitute for curled hair	William Baker	47
54.	Tent, improved	James H. Dakin	ib.
55.	Grinding and polishing saw plates	Richard M. Hoe	48
56.	Press for hay, cotton, &c.	Caleb Martine	ib.
57.	Lamp for burning pine oil	Michael Boyd Dyott	ib.
58.	Stove for culinary and other purposes	Benjamin Shepherd	ib.
	June, 1842.		
1.	Thrashing machine and horse power	Jesse Bowles	178
2.	Steam valves	Stephen Parks, Jr.	179
3.	Planting seed	Wells Kilburn	ib.
4.	Valves for stoves	Henry Stanley	ib.
5.	Water wheels	E. & J. Whitney & W. F. Card	180
6.	Cap plates for rotary cooking stoves	I. French, assignee of M. French	ib.
7.	Saddles with spring side bars	Abraham Freed	ib.
8.	Marine steam engines	Jos. Maudsley & J. Field	ib.
9.	Rotary steam engines	J. T. & B. Beale	181
10.	Steam engine	William Kelley	ib.
11.	Lard lamps	Ellis S. Archer	ib.
12.	Paddle wheels for vessels	Alexander Connison	ib.
13.	Regulating the drag of yarn in cap spinner	Jesse Whitehead	182
14.	Cutting laths, staves, &c.	Ebenezer Day	ib.
15.	Wind mill	John R. Rennington	183
16.	Carriage lock	S. Guss assignee of W. Clayton	ib.
17.	Saw mill	L. Hedges & E. F Johnson	ib.
18.	Steam boiler	L. E. Hopkins	184
19.	Cutting and slitting tortoise shell	William Redeffer	ib.
20.	Spinning, twisting, and curling hair	Hiram Burnham	ib.
21.	Tapping pipes under hydrostatic pressure	H. Ariel Norris	ib.
22.	Seraphines and reed musical instruments	James A. Bazin	ib.
23.	Hydrant cocks	L. Manger, F. D. Davis, & W. Dukehart	185
24.	Smut machine	John Wilson	ib.
25.	Spark arrester for locomotives	Jonathan Hodges	ib.
26.	Turning boot legs	Joseph H Sandford	ib.
27.	Gas meter	C. F. Brown	ib.
28.	Furnace for scrap or pig iron	John C. McManaway	ib.
29.	Cultivator	Barnabas Langdon	186
30.	Drawers for furniture	Oliver Jenkins	ib.
31.	Plough beam	Joel Houghton	ib.
32.	Bee palace	Henry Hiser	ib.
33.	Steam generator	I. N. & S. W. Lesh, J. Deardoff & Z. Beeson	187
34.	Melting and rendering tallow, &c.	L. Montrop	ib.
35.	Cooking and heating stove	Andrew Walker, Jr.	ib.
36.	Power loom for carpets	Thomas Flint	ib.
	September, 1846.		
1.	Ploughs, adjustable clevis for	Samuel Wilt	24
2	Stump extractors	John R Remington	25
3.	Stoves for warming rooms	O. S. Hartshorn, H. M. Payson, & A. Ring	ib.
4.	Yoke for oxen	David Chappel	ib.
5.	Mowing and reaping grain, grasses, &c	Alexander M. Wilson	ib.
6.	Candles, manufacture of	James S. Gwynne	26

7. Hulling rice, coffee, &c.	Clark Jacobs	27
8. Sash fasteners	James Jones	ib.
9. Wood screws, blanks for	Thomas W. Harvey	ib.
10. Saw mill, tail block for	Horace Merrill	28
11. Fencing and ditching	William C. Bussey	ib.
12. Hemp, breaking	Thomas L. Fortune	ib.
13. Garment measures	William R. Acton	ib.
14. Wagons, sleighs, &c., drawing	Mylo Knapp	29
15. Heating rooms, mode of	John H. B. Latrobe	ib.
16. Plough for corn, potatoes, &c	John & Cyrus Krauzer	ib.
17. Railroad trucks	John F. Rogers	ib.
18. Straw cutter	G. Catchpole	30
19. Bedsteads, windlass and other	J. W. Adams assigned to S. H. Lewis & J. Clapp	ib.
20. Cooking stove	W. H. Allen & James Slocum	ib.
21. Sewing cloth, &c., machine for	Elias Howe, Jr.	31
22. Excavating and embanking ditches	Samuel Thrailkill	32
23. Spark arrester	Augustus Hamann	33
24. Burr stones, artificial	E Cutter & S Blanchard	ib.
25. Curing meat in vacuum	Augustus C. Allen	ib.
26. Grinding surface in mills, forming a	Jesse Fitzgerald	ib.
27. Printing presses	William W. Marston	ib.
28. Balance for weighing	Joshua Gibbs	34
29. Mill feed, scouring and dressing	Edward Bradfield	ib.
30. Coffer dams, constructing	Samuel S. Walley	ib.
31. Blacksmiths' forges or furnaces	James R. Hobbs	35
32. Steelyards	Thaddeus Fairbanks	ib.
32. Plough and cultivator for corn	Isaac Edwards	ib.
34. Bee hive	William Whitcomb	ib.
35. Projectile for killing whales, &c.	Oliver Allen	36
36. Reciprocating steam engine	Daniel Barnum	ib.
37. Cutting straw	Isaac Mayfield	38
38. Fire engine, applying power to	G. Barton, Jr., & L. Button	39
39. Double seaming machine	George R. Moore	ib.
40 Blocks for log carriages for saw mills	Henry Mellish	ib.
41. Glass furnace	T. Leighton, assigned to New England Glass Co.	40
42. Cooking stoves	Jacob Cornelison	ib.
43. Rolling iron	Benjamin Norton	ib.
44. Hames harness	Kasson Frazer	41
45. Drying grain	William W. Alcott	ib.
46. Locking drays, carts, &c.	Elijah Chapman	42
47. Rotary steam engines	James Miller	ib.
48. Kiln drying apparatus	Sebre Howard	ib.
49. Carding wool, cotton, &c.	Charles Bishop	ib.

October, 1846.

1. Mule for spinning cotton, &c	William Mason	89
2. Straw cutter	James T. Wade	95
3 Inclined piston	James Richards	ib.
4. Loom for weaving ribbons, &c.	F V. Ganahl, assigned to C. V. Ganahl	ib.
5. Glass furnace	Deming Jarvis	96
6 Thrashing machine	W. Eddy & T. A. Toplin	ib.
7. Stoves for cooking and warming	Adam C. Conde	ib.
8. Lenses, manufacture of	Henry M Paine	97
9. Cutting laths	James M Winslow	ib.
10. Stock for the neck	Charles Fanshaw	ib.
11. Gas, manufacture of	George Michaels	ib.
12. Sugar from cane, &c.	" "	98
13. Clocks	J. H. Schrock & J. G. Fisher	ib.
14. Gathering fruit	W. Sedgewick & John Brooks	ib.
15. Crimping tool for boots	William Taylor	ib.
16. Straw cutter	William J. Rylander	99
17. Carriage steps	David & E. T. Little	ib.
18. Fire and other engines	Charles W. Grannis	ib.
19. Furnace for the manufacture of articles of iron	William H. Passmore	100
20. Rotary curve for cisterns	Orlando Owen	101
21. Washing machine	H. B. Masser	102
22. Gas engine	Stuart Perry	ib.
23. Fire grate for heating apartments	John Goldenburgh	103
24. Coupling for railroad cars	J. A. Cutting & G. Butterfield	ib.
25. Moulding for castings	Francis N. Still	104
26. Cooking stove	William B. Treadwell	ib.

27.	Shelling corn	James Murray	104
28.	" "	Jonathan W. Gordon	105
29.	Electrical conductor	Rene L'Angais	ib.
30	Lantern for destruction of the bee moth,	Samuel C. Wilt	ib.
31.	Revolving axletree	Isaac Slack	106
32.	Drawing water from wells, and raising heavy weights	Henry W. Sabin	ib.
33.	Stoves	C. H. Rogers & S. H. Hancox	107
34.	Locomotive engines with six or eight driving wheels	Ross Winans	ib.
35.	Preparing grain for flour	J. W. Howlet & F. M. Walker	ib.
36.	Trimming brushes	Benjamin Babbitt	108
37.	Thrashing grain	C. Foster & Levi Jones	ib.
38.	Communicating with different rooms	T. D. Jackson & A. Judson	ib.
39.	Saw gin	Peter Von Schmidt	ib.
40.	Press for hay, cotton, &c.	Nicholas Lampman	110
41.	Saw mills, giving feed to	Nathan Compton	111
42.	Steam engines	N. N. Barlow	ib.
43.	Polishing and finishing cloth	Josiah C Carlisle	112
44.	Cast steel, manufacture of	Josiah Marshall	ib.
45.	Constructing pumps	David Hinman	114
46.	Filter and stop cock	William Read	115
47.	Pessary for a prolapsus uteri	Joel B. Merriman	ib.
48.	Boiler for heating tanning liquids, &c.	Warren Nims	116
49.	Carriages for railways	William Coles Fuller	ib.
50.	Swingletree for carriages	H. C. Wiatt	117
51.	Cutting screws for bedsteads, &c.	Joseph Guild	ib.
52.	Cooking range	Moses Pond	118
53.	Tailors' measures	Benjamin G. Martin	ib.
54.	Piano Forte	John Schriber	ib.

November, 1846.

1.	Drill for planting wheat	Henry W. Smith	157
2.	Artificial legs and feet	Benjamin F. Palmer	ib.
3.	Scraping and sweeping chimnies	James Slaughter	ib.
4.	Shower bath	Horace Wells	ib.
5.	Wooden bridges	Lowman Gay	158
6.	Printing and coloring maps	A. D. M'Kenzie	ib.
7.	Pen and pencil case	Jacob D. Hatcher	ib.
8.	Reserve for lead in pencil cases	Albert G. Bagley	ib.
9.	Guard for cap spinners	William Cundell	159
10.	Dry docks	Hugh K. Wagner	ib.
11.	Tide water wheel	Thomas Rowand	ib.
12.	Water wheels	Hiram Munger	ib.
13	Turbine water wheels	Theodore R. Timby	160
14	Rotary shears for cutting metal	L. & L. J. Lamb	ib.
15.	Drawing frame for spinning yarn	J. Pray & C. Stafford	ib.
16.	Performing surgical operations	C. T. Jackson & W. T. G. Morton	161
17.	Coffee roaster	James W. Carter	ib.
18	Washing machine or rotary fulling mill	Ira Avery	ib.
19.	Handling hides in tanning	A. H. Beschormann	162
20	Cider mill, for pressing &c., apples	G. W. D. Culp	ib.
21.	Rotary steam engine and pump	Elisha Hale	ib.
22.	Tuyeres for furnaces	Melvin M'Kay	ib.
23.	Forge tuyere	Daniel C. M'Millen	163
24.	Circular shears for cutting metal	Samuel Hall	ib.
25.	Cutting flocks for woolen cloth	Asa Barber	ib.
26.	Cutting fodder	Luke S. Rand	ib.
27.	Cutting grass	Isaac Lard	ib.
28	Harness saddle	John T. Dennison	164
29.	Reaping and harvesting grain	Andrew J. Cook	ib.
30.	Door fasteners	L. R. Livingston, J. J. Roggen, & C. Adams	ib.
31.	Flues of cooking stoves	D. S. Payson, N. Burch, & R. M. Davis	ib.
32.	Cutting wood screws	Thomas J. Sloan	165
33.	Harpoons	J. Holmes & A. West	ib.
34	Cutting sheet metal	W. Bulkley & P. Norton	ib.
35.	Truss for hernia	Adolph F. Ahrens	166

December, 1846.

1.	Cutting Screws	Peter H. Watson	166
2.	Making barrels, casks, &c.	Philip Estes	ib.
3.	Hillside plough	James Rorabough	ib.
4.	Cooking stove	Samuel & G. J. Conrad	167
5.	Harpoon	Charles Randall	ib.

6. Weaving looms . . . Melchoir Bretzger . . 167
7. Gun cotton . . W. H. Robertson, assignee of C. F. Schonbein . . ib.
8. Polishing cutlery . . William Vine . . ib.
9. Planing, mortising, &c., woods and metals Thomas A. Chandler . 168
10. Making barrels . . Horace Baker . . ib.
11. Fastening round tenons of bedsteads Benjamin Hinkley . ib.
12. Manufacture of sugar . Norbert Rillieux . . 169
13. Bedsteads . . Henry Pace, Sr. . . ib.
14. Weavers' harness . Kasimer Vogel . . ib.
15. Wheels for locomotives and cars . Alexander Small . 170
16. Knobs for doors . . L. R. Livingston, J. J. Roggan, C. Adams, & W. & R. Phillips . ib.
17. Casting door knobs . . William Higgs . . ib
18. Making segars . . Hosea Peirce . . 171
19. Brake for railroad cars . William M'Cammon . . ib.
20. Churn . . Samuel B. Howd . ib.
21. Setting the tire of wheels . George H. Hatcher . . ib.
22. Crank axle for carriages . Oren Tracey . . ib.
23. Cooking stoves . . Samuel Winrott . . 172
24. Washing machine . E. D. Wilson . . ib.
25 Spinning machine . . Hiram F. Wheeler . ib.
26. Washing machine . Edward D. Tippitt . ib.
27. Wheels for railroad trucks . Fowler M. Ray . . 173
28. Crushing and cracking corn and cobs W. Beale, Jr., & B. S. Hale . ib.
29. Cotton mattrasses . . W. H. Robertson . . ib.
30. Skirts for ladies' dressing . Sewell Folsom . . ib.
31. Snow plough for railways . Daniel D. Stilwell . . 174
32. Cooking stove . . Joseph S. Silver . ib.
33. Brake for carriage wheel . Samuel Cope . . ib.
34. Cotton gin . . Edwin Keith . . 175
35 Machine for counting . George W. Edelman . ib.
36. Preventing deposits in steam boilers S. D. Anthony & D. Barnum . ib.
37. Coffee pots . . John R. Remington . . ib.
38 Stoves . . Benjamin Shepherd . ib.
39. Carving wood, stone, &c. . Hezekiah Augar . . 176
40. Side valves for steam engines . Stephen F. Gates . ib.
41. Locomotives . . R. F. Stephens & L. B. Pitcher . ib.
42. Cutting saussage meat . Edward D. Tippett . 177
43. Cooking stoves . . James R. Stafford . . ib.
44. Raw hide whips . . Charles Beader . ib.
45. Seraphines . . Jeremiah Carhart . . ib.
46. Gas burners . . Etienne Maccaud . 178
47. Clocks and time-keepers . C. Boardman & J. A. Wells . ib.

January, 1847.

1. Clocks and time-pieces . C. Boardman & J. A. Wells . 239
2. Truss for prolapsus uteri . Francis Carter . . ib.
3. Cutting and harvesting grain . Clinton Foster . . ib.
4. Excavating, grading, and solidifying roads . . Nathan Parkins . . 240
5. Carriage wheels . . Ira Holmes . . ib.
6. Attaching tugs, &c., to whiffle trees of vehicles . . W. D. Garmo, assignee of W. S. Ellison ib.
7. Mills for grinding grain, &c. . F. B. Hyde, assignee of J. B. Gendebien & A. Houyet . . 241
8. Arresting sparks and creating draft James Montgomery . ib.
9. Toasting coffee . John R. Remington . . ib.
10. Cutting garments . . Miles G Simril . . 242
11. Tin raising machine . Alonzo Heaton . . ib.
12. Knife for cutting timber . Isaac Crossett . . ib.
13 Water closet . . J. Ingram & J. Stuart . . 243
14. Fountain pen, shaft, and penholder . Walter Hunt . ib.
15. Ploughs . . L. Prouty, executor of D. Prouty . ib.
16. Splitting or cutting out plank . J. R. Remington & R. Beale . ib.
17. Fountain for shower bath . Henry Blodgett . . 244
18. Laying rope, twine, &c. . William Joslin . ib.
19. Cutting irregular forms of wood, &c. Timothy Clark . . ib.
20. Horse rakes . . Lewis Swift . . 245
21. Hammers . . Charles Hammond . . ib.
22. Lamps for volatile ingredients Isaiah Jennings . it.
23. Mortising window blinds . Joseph W. Ingle . . ib.
24. Cleaning farms from grass, &c. . Jean Blanc . . 246
25. Pins for fastening clothing . James Rabbeth . ib.

26. Faucet and filter . . Samuel H. Lewis . 246
27. Steering apparatus for ships . Jesse Reed . . 247
28. Planing planks and boards . Job Sheldon . . ib.
29. Presses for cotton, &c, . Alfred C. Jones . . ib.
30. Fastening the draw-strap to the hames tug William D. Hillis . . ib.
31. Smut machines . . Joseph Heygel . . 248
32. Traversing wires across rivers, &c., for suspension bridges . John A. Roebling . . ib.
33. Tension wheels for carriages . James Rowe . . ib.

February, 1847.

1. Closing doors . . Daniel Ball . . 335
2. Attachment to pianos . Moses Coburn . . 336
3. Shower bath . . H. H King . . ib.
4. Stoves . . Charles W. Grannis . ib.
5. Hardening hat bodies . Samuel Lyons . . ib.
8. Self-adjusting trusses . A. W. Patterson . 337
7. Manufacture of treenails . E. Weber & N. O. Mitchell . ib.
8. Floating sectional docks . Samuel Loveland . ib.
9. Slats for Venetian blinds . Lott McGill . . 338
10. Knives for straw cutters . F D. Sampson . . ib.
11. Safety fuse for blasting rocks . Richard Bacon . . ib.
12. Composition for adding to paints Robert Braman . . ib.
13. Harness pads . . C. Pope & K Frazer . . 339
14. Wrought iron cannons . Albert Eames . . ib.
15. Meal of flaxseed, &c. for expressing the oil, Elijah Horner . . ib.
16. Setting up hat bodies . . A. B. Taylor & A. B. Burr . ib.
17. Reaction water wheel . J. Armstrong & H. Herring . 340
18. Mariner's compass . . Ralph Reeder . ib.
19. Pneumatic spring for railway cars John Lewis . . ib.
20. Barrel and hogsheads . . T. Molinier . . 341
21. Wrought iron rails . Thomas Grenell . . 342
22. Cure of curvature of the spine . Cyrus Knapp . . ib.
23. Cutting, thrashing, and cleaning grain D. A. Church L. O. Obert, & W. W. & O. F. Willoughby . ib.
24. Bleaching rosin white . Joseph W. Harman . . ib.
25. Fire escape . . W. W. Van Loan . 343
26. Water gauge for steam boilers H. R. Worthington & W. H. Baker ib.
27. Dressing mill stone . . A Fisk, Jr., L. D. Rumsey & O. S. Gregory ib.
28. Cooking stoves . James H. Conklin . . ib.
29. Sliding scales for cutting coats . Thomas Watt . . 344
30. Ploughs . . George Bartlett . . ib.
31. Railway Switches . . Andrew Ralston . ib.
32. Artificial incubation . L. G. Hoffman . . ib.
33. Corn shellers . . Reuben Chalfante . 345
34. Ploughs . . James H. Conklin . . ib.
35. Mixing and breaking dough . Hosea Ball . . ib.
36. Shingle machine . William F. Fitch . . ib.
37. Planing, tonguing, and grooving boards J. Powell, N. Barlow & E. Holden 346
38. Conveying wagons, &c., across rivers Henry Stanton . . ib.
39. Manufacture of sugar . Antoine M. F. Chevet . ib.
40. Manufacture of leather . F. Durand & O. Pecqueur . 347
41. Trusses . . Halvor Halvorson . . ib.
42. Washing gold ore . Jonathan Sullivan . . ib.
43. Hanging carriage bodies . John Speed . . ib.
44. Mortising machines . S. Fairchild, assignee of R. & S. Fairchild 348
45. Metallic pens . . Albert G. Bagley . . ib.

March, 1847.

1. Welded iron tubes . . Thomas Henry Russell . 409
2. Folding and measuring cloth . Elbridge G. Woodman . ib.
3. Folding and measuring cloth . S. D. Glines, assignee of A. R. Austen ib.
4. Ploughs . . Emanuel Albert . . 410
5. Coal stoves . . John T. Davy . . ib.
6. Planing, tonguing, and grooving plank John Cumberland . . ib.
7. Hanging carriage bodies . John Maxson . . 411
8. Cotton cleaners . . Robert M. Livingston . ib.
9. Steamboats and propellers . Stephen J. Gold . . ib.
10. Horse power . . Jesse Urmy . . ib.
11. Wheels for railroads . Godlove K. Kane . . 412
12. Cutting corks . . Philip C. Traver . . ib.
13. Refining pine oil or spirits of turpentine Norris L. Martin . . ib.
14. Weaving wire for screens . Henry Jenkins . . 413
15. Screens or sieves . Henry Jenkins . . ib.
16. Steam cotton press . . P. G. Gardiner . . ib.

17. Cleaning cotton	Rozell Needham	413
18. Rack wrenches	Z. W. Avery, assigned to B. Webb	414
19. Breaking and cleaning hemp	F. P. Holcomb	ib
20. Boring machines	Jonathan Johnson	415
21. Turning, cutting, and splitting stone	Charles Wilson	ib.
22. Furnace for malleable iron	Alexander Dickerson	ib.
23. Air tight stoves	J. S. Marll & W. J. Ogden	ib.
24. Motion for planing machines	Moses Ingalls	ib.
25. Cast iron plough clevises	John Van Brocklin	416
26. Clocks	John S. Greig	ib.
27. Combing wool	C. G. Sargent	ib.
28. Shirt bosoms	Madelin Tassie	ib.
29. Looms for Brussels carpeting	Erastus B. Bigelow	417
30. Looms	James Haworth	ib.
31. Preventing explosions in steam boilers	Alfred Stillman	ib.
32. Knitting machine	Joseph Vickerstaff, assigned to A. Cummings & W. S. Haines.	418
33. Steam engines	W. Eddy, assignor of S. Norris	ib.
34. Cut off for steam engines	Horatio Allen	ib.
35. Steam valves	Henry H. Grame	419
36. Journal boxes	James Old	ib.
37. Heating ovens	P. Groville & L. U. & E. Mouchette, Assignees of B. Rodrique	ib.
38. Foot stoves	George H. Thacher	420
39. Pumps	Ralph Bulkley	ib.
40. Screening grain	John Bamborough	421
41. Expansion joint for steam engines	Henry R. Dunham	422
42. Looms	Lawrence Holmes	ib.
43. Carriages	A. W. Forward	ib.
44. Furnace bars	John H. Fellows	ib.
45. Augers	A. Newton L. B. Smith, & E. Sandford	423
46. Pneumatic hydraulic engine	Joseph C. Strode	ib.
47. Bobbin stands	Noah C. Piram	424
48. Steam engines	C. Galvani, assignor of J. Clark	ib.
49. Steam cross-cut saw	Lewis Kirk	ib.
50. Reducing and bleaching straw, &c	Lemuel W. Wright	425
51. Ditching and fencing	Elhanan W. Thomas	426
52. Raising water on bars and shoals	Waller Harris	ib.

Acid, manufacture of dry, and of smoking sulphuric—*patent*	253
Acids, on the constitution of Glycerin and the oily	365
Agricultural produce exported from the United States, quantity of	348
——— products of France, mean yearly value of	444
Alabaster, method of bringing out sculpture upon	277
Alkali and chlorine, improvement in the manufacture of—*patent*	63
Alloys of metals, method of uniting metals and—*patent*	254
Antimony, white paint manufactured from	362
Architecture, on the application of geology to engineering and	226
Artesian wells at Venice, account of	236
Arctic Ocean, on the temperature of the	435
Astringent substances for tanning, on the means of testing	145
Atmospheric air, on the dilatation of	207 281
——— jets, Parker's remarks on the velocity of	72
Baltimore Exhibition of American Manufactures, notice of	292
——— and Ohio railroad Co,, annual report of the	1
Base line in surveying, measurement of the	232
Beams, experiments on the strength of wooden and iron	378
Bibliographical Notices.	
Bird's Elements of Natural Philosophy	448
Chemistry applied to the Manufacture of Soap and Candles	122
Coast Survey, report of the Superintendent of the	213
Knapp's Chemical Technology	449
Muller's Principles of Physics and Meteorology	236
Weisbach's Principles of the Mechanics of Machinery and Engineering	289
Blasting, on the use of gun cotton in	364
Bleaching agent and means of recovering it, on chromic acid as a	441
Boilers of marine steam engines with water, apparatus for supplying the	128
Bookbinding, on the ornamental art as applied to ancient and modern	211
Booth, J. C., on the constitution of glycerin and the oily acids	365
Brake for railroad cars, description of Laiguel's safety	235
Bridge, description of Col. Long's composite	202 258

Bridge, notice of the Niagara falls suspension 335
—— over the Conway, description of the tubular 398
———————— a machine for perforating iron plates for the . 374
Bridges, large cast iron girders for 335
Bronzing of metals, on the electro 387
———— different metals, process for 434
Burners, description of a new arrangement of gas 284

Calorific action of an electric current 382
Canal Commissioners of Pennsylvania, annual report of the . . 221 321
—— Company, annual report of the Union 84
Candles, Chemistry applied to the Manufacture of Soap and . . . 122
Cast iron girders for bridges, large 335
——— rails, on the wear of 408
Casting cylindrical pipes, improvements in—*patent* 63
Centre vent reaction water wheels, Parker's remarks on 135
Charcoal at the temperature of low pressure steam, on the reducing power of . 361
Charring animal and vegetable matter, on the power of low pressure steam in . 361
Chemical Technology, notice of Knapp's, ... 449
Chinese magic mirror, description of the 52
Chlorine and alkali, improvement in the manufacture of—*patent* . . . 63
Chloroform, new method of making 362
———— new method of preparing 448
Chromic acid as a bleaching agent, and means of recovering it . . . 441
Coal, explosion on board of a vessel laden with steam 448
Coast Survey, extract from the report of the superintendent of the United States . 229
———— notice of the report of the United States 213
Cochineals, on the commercial value of different 435
Commerce of the lakes and western rivers of the United States . . . 352
————, revenue and population of the United States 350
Con posite bridge, description of Col. Long's 202 258
Copper and other ores, improvement in smelting—*patent* 256
—— ores, improvement in smelting—*patent* 255
Cornwall mining terms, glossary of 293
Cotton in blasting, use of gun 364
Counter or plegometer, description of an improved 67
Crystalization under extreme pressure, experiments on 213
Cylinders for locomotive engines, machinery for boring 372

Decomposition of salts by hot steam 426
Derbyshire mining terms, glossary of 300
Dew, remarks and experiments on the theory of 52
Docks situated upon a tideway, on the formation of entrances to . . . 396

Electric current, on the calorific action of an 382
——— telegraph, experiments with the 383
Electrical phenomena by polarization, an effort to explain . . . 188 264
———— insulation, on the use of gutta percha in 446
Electricity, new mode of lighting by 445
Electro bronzing of metals, on the 387
—— magnetic telegraph for differences of longitude, use of the . . 229
Engine, description of Mr. Samuel's railway express 88
Engineering and architecture, on the application of geology to . . . 226
————, by J. Weisbach, notice of principles of the mechanics of machinery and . 389
Engraving called stylography, description of a new process of . . . 64
Entrances to dock on tideways, on the formation of 396
Explosion causing the great fire in 1845 in New York, Dr. Hare's remarks on the 452
———— of gas in metallic mines, notice of the 363
———— the locomotive "Engineer" on the Reading railroad . . . 407
———— a steam boiler in Dillwyn street, report on the . . . 456
———————— —— at Manchester 378
———— on board of a vessel laden with steam coal 448

Fares of railroads in the United States, comparative 155
Fluids, on the dilatation of elastic 207
Foundations, particularly the screw pile and moorings, on sub-marine . . 393
France, cost of locomotives in 335
France, mean yearly value of agricultural products in 444
Franklin, Dufrey, and Ampere, objections to the theories of . . . 188 264
French smelting terms, glossary of 318
Friction hammer, description of the 388

FRANKLIN INSTITUTE.

Proceedings of the Monthly Meetings . . 146 217 289 390 451
Election for officers and managers for 1848 . . . 148

Committee on Science and the Arts.

Report on Durand & Pecqueur's manufactures of leather . . 458
——·—— explosion of steam boiler in Dillwyn street . . 456
——·—— Lieut. H. S. Stelwagen's coast survey sounding apparatus . 392

Gas burners, description of a new arrangement of . . . 284
—— in metallic mines, notice of the explosion of . . . 363
—— sulphate of iron for purifying 387
—— works, improvements in purifying gas, and in the treatment of the products of—*patent* 69
Gases, on the determination of the density of . . . 5
——— under pressure, on the dilatation of 28
Gauge, notice of Smith's steam . . . . .
——— pipe for measuring the flow of water . . . 402
Geology, on the application of, to engineering and architecture . . 226
German smelting terms, glossary of 318
Girders for bridges, large cast iron 335
Glass blowing apparatus, description of a 377
—— manufactures, on the curiosities of 385
—— vessels hermetically, method of closing . . . 287
Glossary, English and foreign mining 293
Glycerin and the oily acids, on the constitution of . . . 365
Gun cotton in blasting, on the use of 364
Gutta percha in electrical insulation, on the use of . . . 446

Hammer, description of the friction 388
Hare's, Dr., objections to the theories of Franklin, Dufrey, and Ampere, with an effort to explain electrical phenomena by polarization . . 188 264
——— — remarks on the explosion causing the great fire in 1845 in New York 452
Hydraulic lifting jack, description of a new 372

Iron and wooden beams, experiments on the strength of . . 378
—— for purifying gas, on the use of sulphate of . . . 387
——— railroad bars or locomotive tires, new method of treating—*patent* . 119
—— girders for bridges, large cast 335
—— improvement in the manufacture of—*patent* . . . 62
—— plates, description of a machine for perforating . . . 374
—— rails, on the wear of cast 408
—, steel, and sheet iron, method of welding . . . 277
—— trade of Philadelphia 349
Isthmus of Suez, cutting through the 153

Jets, Parker's remarks on the velocity of atmospheric . . 72
Jones, D.. Thos. P., notice of the death of 292

Lake coasts in the United States, extent of . . . 355
Lakes and western rivers of the United States, commerce of the . . 352
Lamps, on a new liquid for 384
Leather, report on Durand & Pecqueur's manufactures of . . 458
Lifting jack, description of a new hydraulic . . . 372
Light, on the polarization of 435
Lighting by electricity, new mode of 445
Locomotive engines, on fitting up cylinders for . . . 372
———— "Engineer," account of the explosion of the . . . 407
———— tires, method of treating iron for railway bars or—*patent* . 119
Locomotives in France, cost of 335
Long, Col. S. H., description of a composite bridge invented by . . 202 258
Longitude, use of the electro magnetic telegraph for differences of . . 229

Magic mirror, description of the Chinese . . . 52
Magnetic telegraph for differences of longitude, use of the electro . . 229
Magnetism, account of a new application of . . . 68
Magnets, description of a new mode of making artificial . . . 60
Manchester, account of the explosion of a steam boiler at . . 378
Manometer, description of an improved 285
Marine steam engines building in New York . . . 349
———————— with fresh water, Erricsson's apparatus for supplying . 128
Materials, experiments on the strength of . . . 378

Mechanics of Machinery and Engineering, by J. Weisbach, notice of . . 389
Metals and alloys of metals, method of uniting—*patent* . . 254
——— on the electro bronzing of 387
——— process for bronzing 434
Meteorology, notice of Muller's Principles of Physics and . . 236
Mine Hill and Schuylkill Haven Railroad Co., annual report of the . 149
Mines, notice of the explosion of gases in metallic . . . 363
Mining glossary, English and foreign 293
Moorings, on the sub marine foundations, particularly the screw pile and . 393
Morfit's chemistry applied to the manufacture of soap and candles . 122

Natural Philosophy, notice of Bird's elements of . . . 448
Navigation of the western waters of the United States, extent of steam . 354
New York, marine steam engines building in . . . 349
———, Dr. Hare's remarks on the explosion causing the great fire in 1845 in . 452
Niagara Falls suspension bridge, notice of the . . . 335
Nitre to explode with water, Dr. Hare's remarks on the competency of 452

Ocean, on the temperature of the Arctic 435
——— steamboats, speed of the 236
Ore of platinum, new method of treating the 388
Ores, improvement in smelting copper—*patent* . . . 255
——————————— and other—*patent* . . . 251

Parker's, Z., remarks on the centre vent reaction water wheels . . 135
——————— reaction water wheels . . . 49
——————— the velocity of atmospheric jets . . 72
Patents, report of the committee in the United States Senate on the extension of . 248
Pennsylvania Canal Commissioners, annual report of the . . 221 321
——— Railroad Co., annual report of the . . . 73
Philadelphia, iron trade of 349
Photographic image of the solar spectrum, on the colored . . . 383
Physics and Meteorology, notice of Muller's Principles of . . 236
Pine apples raised by steam 277
Pipes, improvements in casting cylindrical—*patent* . . . 63
Pistons, machine for registering the variation in the velocity of . . 67
Plague, on the origin of the 286
Platinum, new method of treating the ore of 388
Plegometer, description of an improved counter or . . . 67
Polarization, an effort to explain the electrical phenomena by . 188 264
——— of light, on the 435

Railroad, account of the explosion of the locomotive "Engineer" on the Reading . 407
——— bars and locomotive tires, method of treating iron for—*patent* . 119
——— cars, description of Laiguel's safety brake for . . . 235
——— company, annual report of the South Carolina . . 331
——— " " " " Baltimore and Ohio . . 1
——— " " " " Mine Hill and Schuylkill Haven . 149
——— " " " " Pennsylvania . . . 73
——— corporation, " " " Western . . . 328
Railroads in the United States, account of the . . . 408
——————————— comparative fares of the . . . 158
Rails, on the wear of cast iron 408
Railway express engine, description of Mr. Samuels' . . . 88
Regnault, M. V., account of the experiments to determine the principal laws and numerical data which enter into the calculations of steam engines . 136 207 278 356 437

Salts by hot steam, on the decomposition of 427
Screw pile and moorings, on sub-marine foundations, particularly the . 393
Sculpture upon alabaster, method of bringing out . . . 277
Sea defences, illustration of the principles of . . . 395
Silver in Spain, production of 351
Smelting copper ores, improvements in—*patent* . . . 255
——— " and other ores, improvement in—*patent* . . . 256
——— terms, glossary of French, Spanish and German . . 318
Soap and Candles, Morfit's chemistry applied to the manufacture of . . 122
Soda upon a stoneware jar, action of a solution of caustic . . 212
Solar Spectrum, on the colored Photographic image of the . , 383
South Carolina Railroad Co., annual report of the . . . 331
Spanish mining terms, glossary of the 304
Specific gravities of bodies expeditiously, apparatus for ascertaining . 66
Steamboats, on the speed of ocean . . . , 236
Steam boiler at Manchester, account of the explosion of a . . 378

Steam boiler in Dillwyn street, report of the explosion of a . . 456
——, improved manometer for measuring the force of . . . 286
—— engines building in New York, marine 349
———— account of the experiments to determine the principal laws and numerical data which enter into the calculations of 136 207 278 356 437
———— with fresh water, Erricsson's apparatus to supply marine . 128
—— gauge, notice of Smith's 23
—— in charring animal and vegetable matter, on the power of low pressure . 361
—— navigation on the western waters of the United States, extent of . . 354
—— new use of waste 277
—— remarks on high pressure 21
Steel and sheet iron, method of welding iron 277
Stylography, description of a new process of engraving called . . . 64
Suez, cutting through the isthmus of 153
Sulphate of iron for purifying gas, use of 387
Sulphuric acid, manufacture of dry and of smoking 253
Suspension bridge, notice of the Niagara Falls 335

Specifications of Patents.

Acid, manufacture of dry and of smoking sulphuric—*Prelier's* . 253
Alkali and chlorine, improvement in the manufacture of—*Dunlop's* . 63
Copper and other ores, smelting—*Napier's* 256
—— ores, smelting—*Napier's* 255
Cylindrical pipes, improvement in casting—*Stewart's* . . . 63
Gas and treatment of the products of gas works, purifying—*Johnson's* . 69
Iron for railroad bars and locomotive tires, preparing—*Ames'* . 119
——, improvement in the manufacture of—*Crane's* 62
Metals and alloys of metals, method of uniting—*Perlbach's* . . 254

Tanning, means of testing the value of astringent substances for . . 145
Technology, notice of Knapp's Chemical 449
Telegraph, experiments with the electric 383
———— for differences of longitude, use of the electro magnetic . 229
Temperature of the Artic Ocean 435
Thompson, J, on a plan for obtaining pure water from the atmosphere for the supply of vessels at sea, &c. 199
Tilghman, R. A., on the decomposing power of water at high temperatures . 142
Tin ware, &c., description of a wiring machine for the manufacture of . 384
Towns and cities, on the application of geology to the supply of water to . 226
Tubular bridge at Conway, description of the 398

Union Canal Co., annual report of the 84
United States, account of the railroads in the 408
———— commerce, revenue and population of the 350
———— " of the lakes and western rivers of the . . 352
———— comparative fare of railroads in the 155
———— extent of steam navigation on the western waters of the . 354
———— " the lake coast in the 355
———— quantity of agricultural produce exported from the . . 348

Velocity of pistons, machine for registering the variation in the . . 67
Venice, account of the artesian well at 236
Vessels at sea, plan for obtaining pure water from the atmosphere for the supply of . 199
Votes in the National Assembly, the manner proposed for taking the . . 443

Waste steam, new use of 277
Water at high temperatures, on the decomposing power of . . . 142
—— from the atmosphere for the supply of vessels at sea, plan for obtaining pure 199
—— gauge pipes for measuring the flow of 402
—— to towns and cities, on the application of geology to the supply of . 226
—— wheels, Z. Parker's remarks on reaction 49
—— " " " centre vent . . . 135
Welding iron, steel, and sheet iron, method of 277
Western railroad corporation, annual report of the 328
White lead, a substitute for 288
—— paint manufactured from antimony 362
Wiring machine for the manufacture of tin ware, &c. 384
Wooden beams, experiments on the strength of iron and . . 378